INTERAVIA

REVIEW OF WORLD AVIATION

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European Air Transport

Automation

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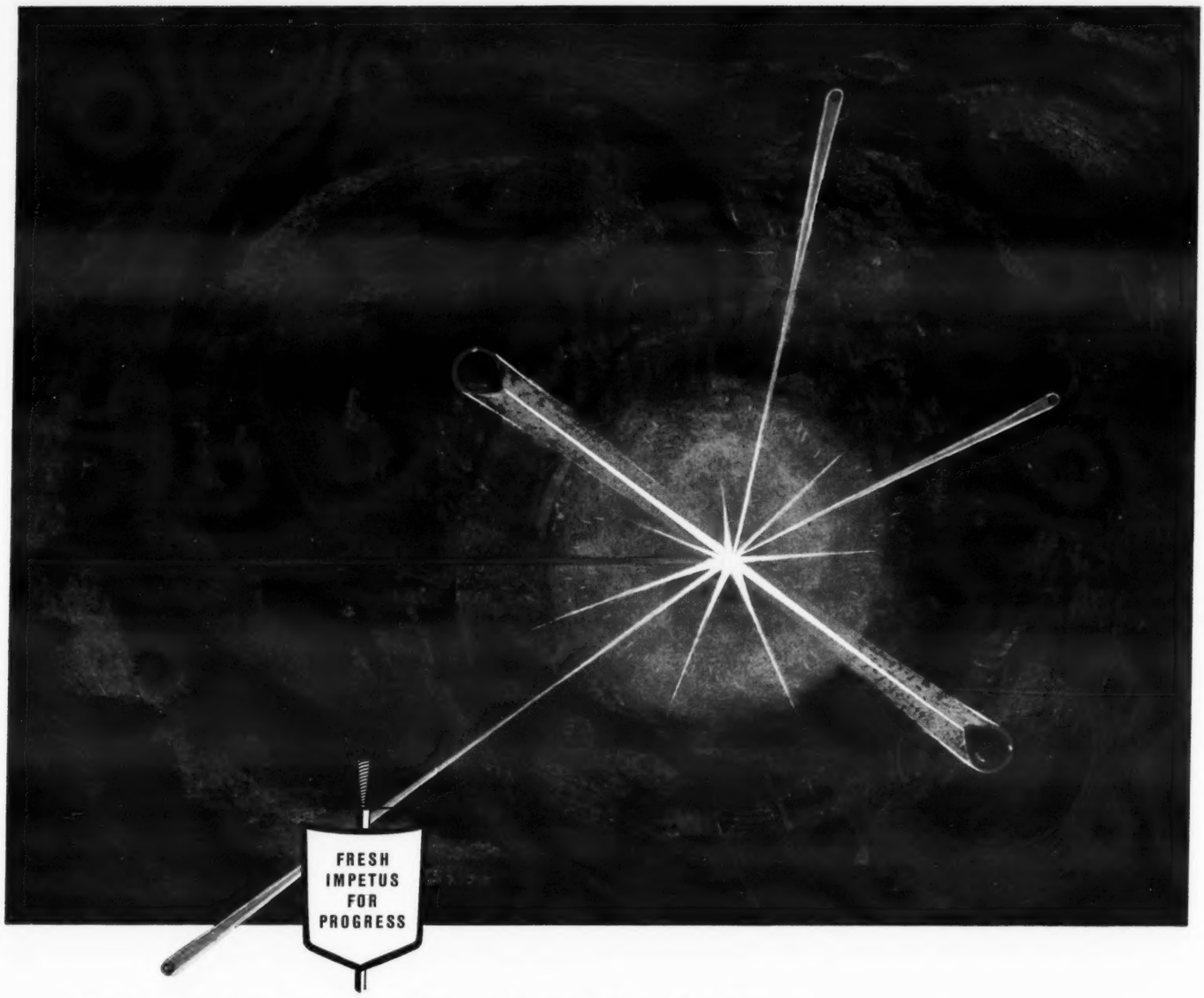
VOLUME XIII

No 3/1958



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INTERAVIA

Review of World Aviation

Volume XIII **No. 3** **March 1958**

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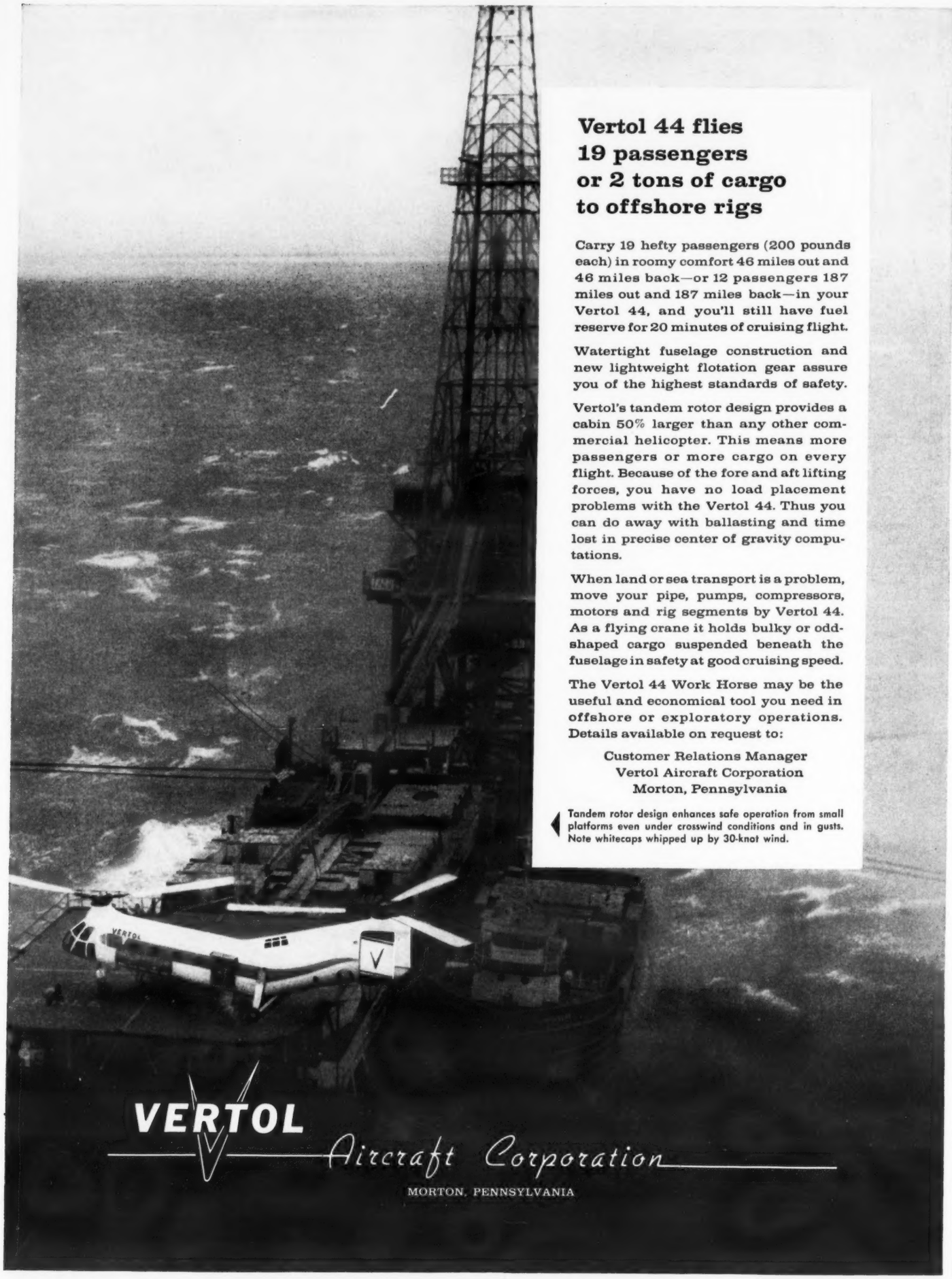

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REPORT ON MAINTENANCE

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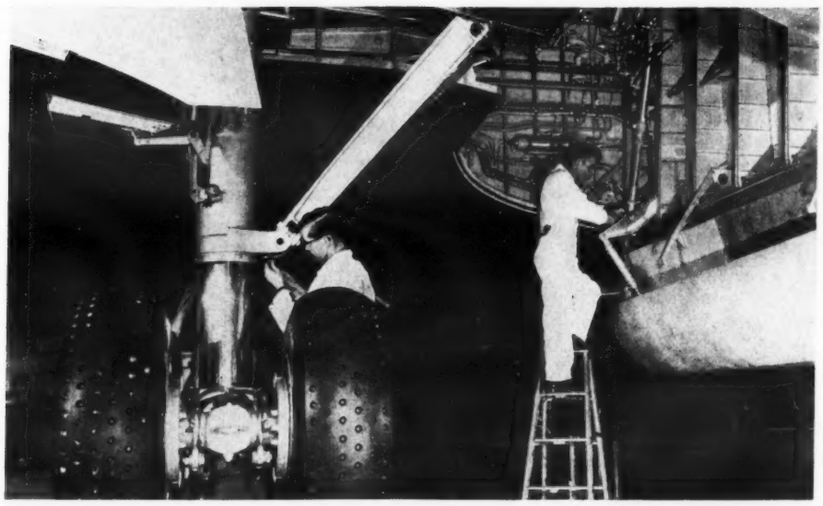

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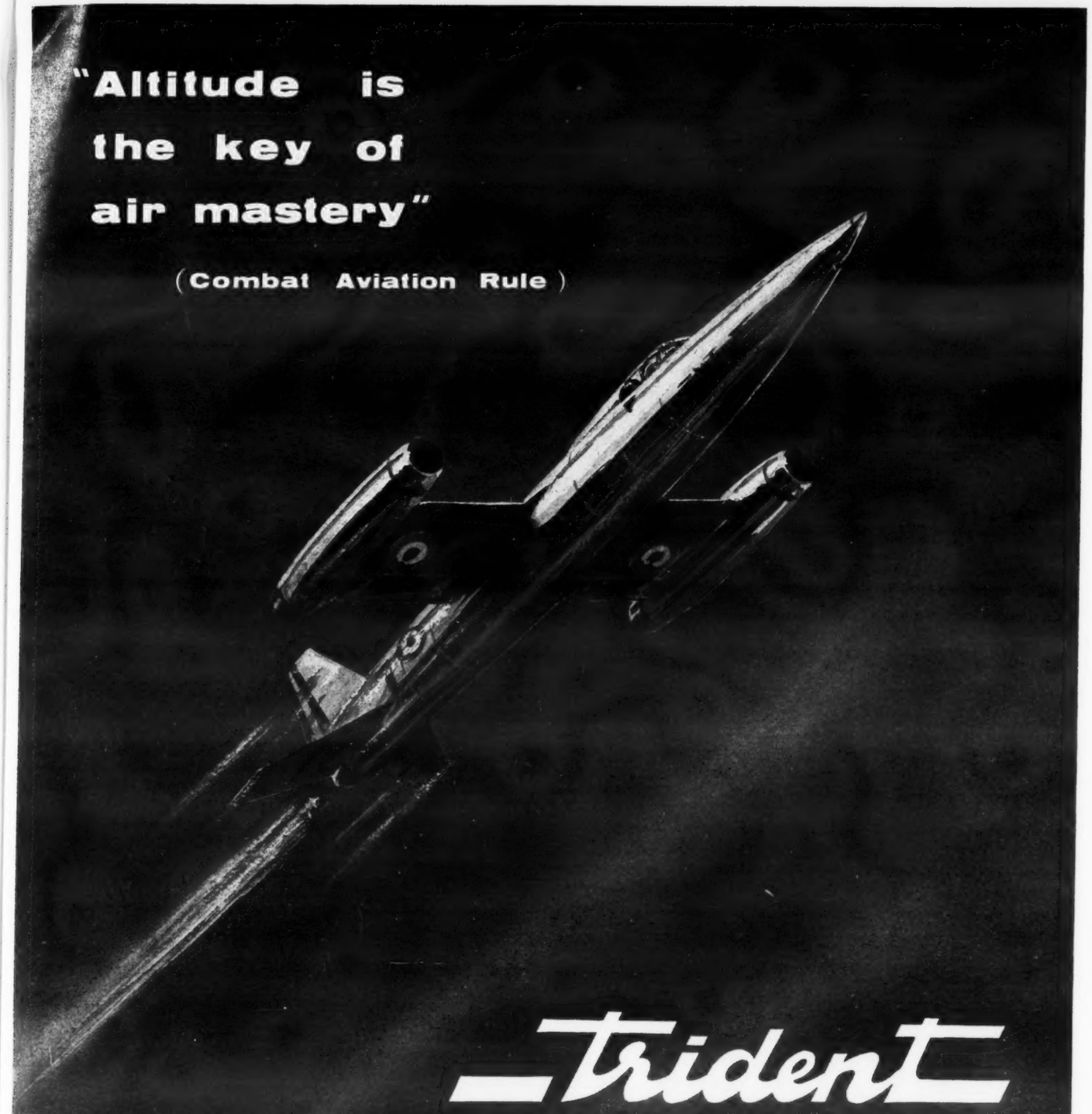

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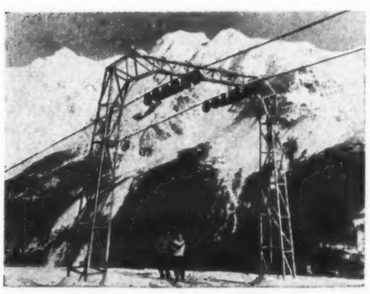
Can you imagine how happy these two people feel ? The " Suger cake " is the Matterhorn (Alpes valaisannes).

On the sunny side of good old Earth. This train will take you right into the heart of the Jungfrau (Bernese Oberland).



And here is the way to climb a mountain without getting tired. In front of the majestic Mont-Blanc. French Savoy.

GENEVA

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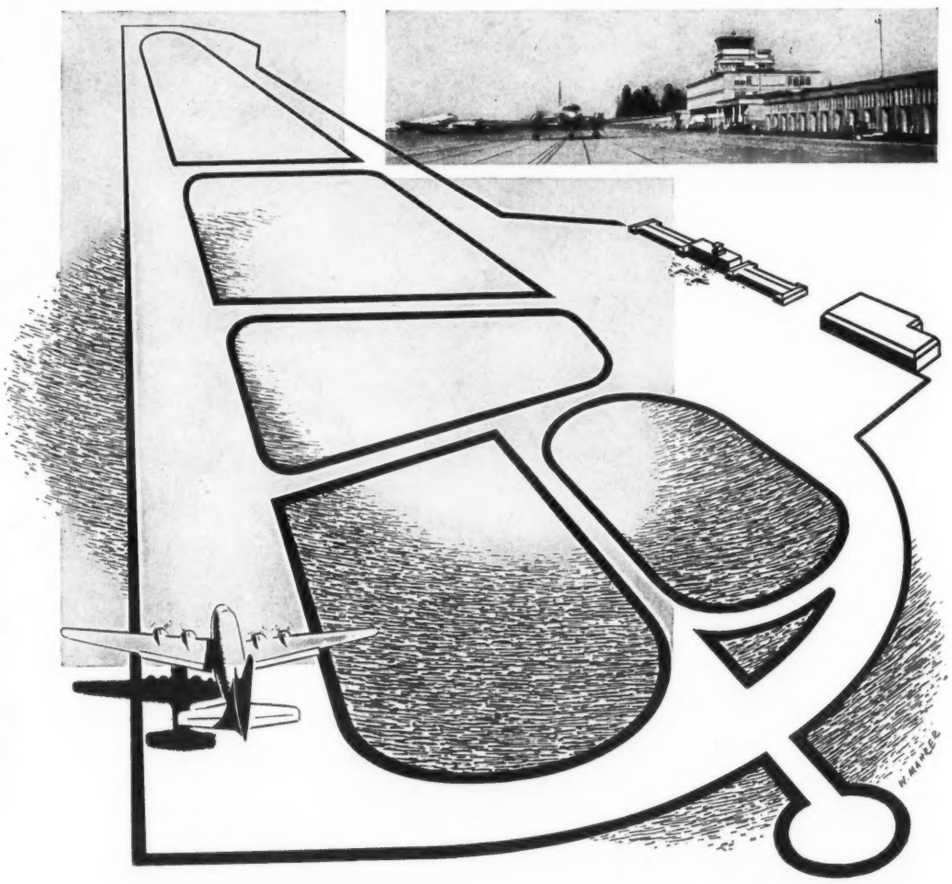

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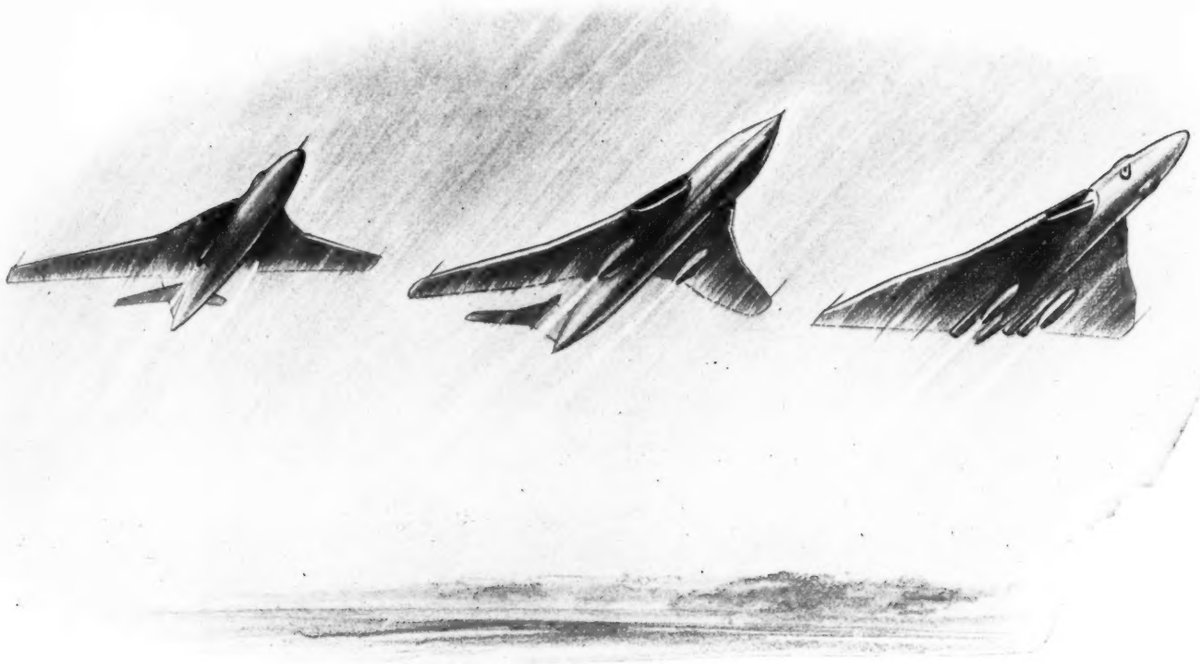

de Havilland liquid-propellent assisted-take-off rocket engines are in production for the Valiant (Super Sprites) and the Vulcan and Victor (Spectres).

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Variable thrust versions of the Spectre are in production for other military applications.

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INTERAVIA

Deadline Notes

No. 3, 1958

● **Flying Atar work to continue :** The "Parisien Libéré" report published in the *Interavia* February issue that development work on the *Flying Atar* and on the C-450 coleopter had been discontinued has been denied by Société Nationale d'Etudes et de Construction de Moteurs d'Aviation. SNECMA is determined to complete the development and testing of the *Flying Atar* and the C-450 VTOL prototype without the help of private capital. Testing of the P.3 *Flying Atar* continues at Melun-Villaroche according to schedule, and construction of the C-450 coleopter is advancing rapidly at the Nord-Aviation works. The C-450 is now being assembled and is due to be completed before the summer.

● **The French Government** has agreed to make a repayable loan of 5,000,000,000 French francs to Sud-Aviation to speed up production of a second batch of SE.210 *Caravelles* (Type 1). The company expects to sell between 120 and 150 *Caravelles*, and the rate of production will reach four aircraft a month at the end of this year. Sud-Aviation has developed a second version of the *Caravelle* to follow the batch at present being built.

● **Georges Héreil,** President of Sud-Aviation, the French aircraft industry's biggest group, and a director of a number of major concerns such as Schneider-Creusot, has been elected as President of Papeterie de la Chappelle, a leading French paper manufacturer. It must be emphasized that Georges Héreil will remain the head of Sud-Aviation, in addition to his new duties. It is possible that Louis Giusta, at present deputy Director General, will be elected as Director General of Sud-Aviation.

● **The 1,000th Marboré turbojet engine** has been delivered by the Turboméca works. To celebrate the occasion, Louis Christiaens, Secretary of State for the Armed Forces (Air), accompanied by other officials and the heads of a number of leading aircraft companies visited Turboméca's modern factory at Bordes which provides 36,680 m² of floor space. Joseph Szydlowski, President and Managing Director of Turboméca, revealed that 1,000 *Marborés* had been built in the United States under licence by Continental Aviation and Engineering Corp. which had also developed an efficient system of controlling the boundary layer through use of the *Artouste* turbine. Louis Christiaens, for his part, said that there were high hopes for the *Bastan* turboprop engine which will power the light aircraft destined for service overseas. Several of these engines are at present undergoing bench tests. The current production rate of 30 *Marborés* per month will in future be increased to 70 a month (including spares).

● **Aerometallurgica Regionale (Aeromere),** of Trento, a firm with a capital of 10,000,000 lire, has temporarily rented the workshops of Aerocaproni Trento at Gardole, and purchased the aircraft manufacturing division of Società Legnani Pasotti, of Brescia. The tools formerly belonging to Pasotti were brought to Trento and will be used for the quantity production of F.8 aircraft. Manufacturing rights for this aircraft have been acquired by Aeromere from Aviamilano. The close collaboration between the four companies (Pasotti, Aerocaproni, Aviamilano and Aeromere) has arisen from the fact that all the aircraft developed by them since the war were designed by Ing. Stelio Frati, of Milan Polytechnical Institute. Frati formerly worked for Società Italiana Ing. Angelo Ambrosini & Co., Milan.

● **Fairchild Camera and Instrument Corp.** has concluded an agreement with Ottico Meccanica Italiana & Rilevamenti Aerofotogrammetrici, Rome, whereby the Italian company will undertake the overhaul of airborne cameras in Europe.

● **Field Aircraft Services Ltd.,** London, will open a Continental office in Geneva, where it will also represent the Hunting Group. In charge of the new office will be H. St. George Bond, Overseas Sales Manager.

● **Toronto's Institute of Aerophysics** will double existing facilities, and it is hoped that construction of new buildings will start in April. The fate of the Institute, which is doing important work on ground level simulation of satellite flight, had been in jeopardy for some time because of lack of money. Some $550,000 has now been raised, with the University of Toronto contributing $250,000, the A.V. Roe (Canada) group $50,000 and a further $6,000 from other companies in the Canadian aviation field. Two special grants totalling $250,000 made by Canada's Defence Research Board in 1955 and 1957 for fundamental research, which have not yet been spent, will go to equip the new laboratory. The Institute's present laboratory at Downsview is believed to be the only one in the Western World with apparatus capable of simulating at ground level the condition of artificial satellite flight in near-vacuum atmosphere several hundred miles up. The team of scientists headed by Professor G. N. Patterson is also working on revolutionary concepts of flight at speeds very many times that of sound.

● **Declining profits** affect the entire transportation industry in the United States. A study published by the U.S. Chamber of Commerce under the title "Transport—Review and Outlook" summarizes the position in these words : "The darkest part of the transportation picture for 1957 concerned net revenues. Persistently increasing costs for labour, material, and equipment more than offset any gains realized in gross revenues. With the decline in general business activity in the fourth quarter, the net revenue situation became steadily worse and in some cases critical..." In the Air Transportation section, the report cites the following figures for domestic trunk lines : Gross revenues rose from $1,262,000,000 in 1956 to $1,433,000,000 last year, an increase of 13.5 percent. At the same time, expenses went up from $1,162,000,000 to $1,385,000,000, a rise of 19 percent. Net profit fell from $58,000,000 in 1956 to $25,000,000 in 1957, a decrease of 56 percent.

● **The overall deficit of Argentina's state-owned industries** amounted to 4,885,000,000 pesos for last year. The railways sustained a loss of 2,400,000,000 pesos and the Buenos Aires Transport Authority 1,000,000,000 pesos. Next came the State-owned oil industry. Aerolineas Argentinas took fourth place with a deficit of 243,000,000 pesos. (100 pesos = U.S. $3.00.)

● **The discussions between France and the United States**—broken off shortly before Christmas—on a request by Air France for an Arctic circle route between Paris and California have been resumed. A proposal was made in Washington which would give Air France landing rights in San Francisco or Los Angeles if the company renounced its existing landing rights at Houston (on the New York-Mexico City route).

● **The nine Air France Viscount 701s,** which had been grounded on January 25th, will be put back into service in May, according to a statement by the company's President Max Hymans. Three of the aircraft have been sent to Vickers for the necessary modification—replacement of part of the wing spar—the rest and being modified by Air France.

● **A Libyan national airline company** is to be established shortly in Tripoli. A strong interest in the new company will be held by Alitalia, Linee Aeree Italiane. Initially, the company plans to operate a frequent service between Tripoli and Benghazi with Convair 440 aircraft, and a DC-3 service between Tripoli and Sebha. Later, flights are to be inaugurated to Tunis and Cairo, and possibly also to Asmara by way of Benghazi, Cairo and Khartoum. The new airline will use Convair 440s and Douglas DC-3s made available by Alitalia. The new company will probably be known as Aero Libia.

● **The Hungarian airline Malev** intends to inaugurate regular air services between Budapest and Amsterdam via Prague on March 1st. Flights will initially be made once a week, to be stepped up to twice a week in the summer. The aircraft used will be Ilyushin Il-14s. A Hungarian delegation of nine has arrived in Holland for talks with Dutch civil aviation officials and to make final preparations for the inauguration of the new service. K.L.M. Royal Dutch Airlines already operates four flights a week between Amsterdam and Budapest.

● **Aerlinte Eireann Teoranta,** the Government-owned airline and sister company to Aer Lingus, has announced plans to start its own tri-weekly economy class service between Dublin and New York next April. The aircraft used will be three Lockheed 1049H *Super Constellations* leased from Seaboard and Western Airlines. The offices and reservation centre will temporarily be at Ireland House, 33 East 50th Street, New York.

● **South African Airways** has concluded a contract with Boeing Airplane Co. for three Boeing 707/320 jet airliners for delivery in July, August and September 1960. Surprisingly, S.A.A. chose American engines—Pratt & Whitney J75s—to power the aircraft, rather than British-made Rolls-Royce *Conways.*

Workshop Briefs

• On February 9th, 1958, the Générale Aéronautique Marcel Dassault *Super Mystère B.4* made its first flight at Melun-Villaroche. This version of the *Super Mystère* is powered by a SNECMA *Atar 9* of 13,230 lb. thrust with afterburner, which is considerably more powerful than the units equipping the B.2 and gives the aircraft improved performance in both level flight and climb.

• The prototype of the Morane-Saulnier 1500 *Epervier* single turboprop aircraft is being assembled at the company's Puteaux plant. By the time these lines are published, the prototype, which is powered by a Turboméca *Marcadau* turbine, will probably have been completed and sent to Villacoublay for flight testing.

• The *Psholka (Little Bee)* feeder and communications aircraft, designed by O.K Antonov and now in production in the Soviet Union, has been designated AN-14. It is a strutted high-wing aircraft equipped with two ASh-21 700 h.p. engines, and has a maximum speed of approximately 125 knots ; the stalling speed is not more than 27 knots. Apparently, the AN-14 will be capable of operations from temporary runways ; take-off and landing distances are less than 330 ft.

• Several versions of the General Electric J79 power unit are in course of development or production. Particularly mentioned is the J79-GE-4 version, reportedly intended for the U.S. Navy. Mention has also been made of the J79-GE-5, intended for equipping later versions of the Convair B-58 *Hustler,* and the J79-GE-7 for later versions of the Lockheed F-104. The J79-GE-7 will reportedly have a markedly increased turbine diameter compared with the earlier versions of the J79.

• Plans for a space bomber capable of orbiting in outer space at 18,500 m.p.h. are being worked out by Douglas Aircraft, according to the Los Angeles "Mirror-News". The company has a $1,000,000 U.S.A.F. study contract to carry on the research work, according to this newspaper.

• First tests of a new VTOL experimental aircraft developed by Robertson Aircraft Corp., a subsidiary of Aero Design & Engineering, have been carried out. 2 × 340 h.p. Lycoming GSO-480s ; four seater ; for military deployment. Principle—diversion of propeller slipstream.

• Two further prototypes of Japan's Fuji T1F2 jet trainer are in production, and by the end of 1958 another seven pre-production models should be completed.

• Some details of the 1,000 s.h.p. Armstrong Siddeley P.182 propeller-turbine can now be published : take-off and maximum power 1,100 s.h.p., plus 200 lb. net thrust ; maximum continuous power 960 s.h.p., plus 180 lb. net thrust ; maximum recommended power 810 s.h.p., plus 165 lb. net thrust. Overall length 59.975 inches ; weight approximately 600 lb. The P.182 has a two-stage axial compressor followed by a one-stage centrifugal compressor ; annular combustion chamber ; three-stage axial turbine.

• The first production model of the SAAB J 35A *Draken* supersonic all-weather fighter made its first flight on February 15th, 1958. The production model differs from the prototype in certain equipment and also, to some degree, structurally. The most important difference is the utilization of the more powerful Rolls-Royce *Avon* unit (Swedish designation RM.6) which is fitted with a Swedish-designed afterburner. It has been announced that other versions of the *Draken* are to follow : the J 35A, which is now in production, will in due course be followed by an improved version, the J 35B, which is now on order. The J 35B will have a more powerful engine, heavier armament, and improved fire control equipment. A third version, the J 35C, will be a two-seat, dual-control aircraft intended primarily for the training role.

• A reconnaissance version of the Fiat G.91 light strike fighter is now being developed by Fiat Aviazione, with the designation G.91R.

• *Alti-Cruiser* is the designation of a recently announced new version of the twin-engined *Aero Commander* executive aircraft, developed by Aero Design & Engineering. It has a pressure cabin and two 340 h.p. Lycoming engines. Price $183,750. The aircraft is expected to be put on the market this year.

• First taxying tests of the Ryan *Vertiplane* VTOL experimental aircraft have been carried out at Lindbergh Field, San Diego.

• The U.S. Air Force, on behalf of the Army, expects to receive detailed contractor proposals in March for the development of a 250 h.p. turboshaft engine which the Army requires for various utilizations, including a powerplant for a new artillery observation aircraft. The Army's research and development officials are calling for an engine with an overall length of 24-36 inches and a diameter of 12-15 inches, with a complete weight, including gearbox, of under 100 lb. The open design competition has attracted wide interest from engine manufacturers, and many designs are expected to be based on a combination centrifugal-axial compressor arrangement.

Fairey flies the first Vertical Take-off Airliner

Adding achievement to achievement, Fairey Aviation have now built potentially the most important transport aeroplane in the world, the Fairey Rotodyne.

Carrying 48 passengers or 4½ tons of freight it takes off vertically as a helicopter and having gained height flies forward as a normal twin-engined airliner.

It is the most adaptable rotary-wing aircraft in the world and the first to offer operating economy directly comparable to that of fixed-wing aircraft over ranges of up to 400 miles.

The arrangement within the Rotodyne's capacious fuselage can readily be adapted to suit civil or military applications.

Powered by two Napier Eland propellor-turbines with Fairey Pressure-Jets at the rotor-tips for take-off and landing.

FAIREY *Rotodyne*

48 passengers · 185 m.p.h. cruising speed

400 miles maximum range.

THE FAIREY AVIATION COMPANY LIMITED · HAYES MIDDLESEX

ENGLAND · AUSTRALIA · CANADA

Operation Call and Haul

Fifteen U. S. Army Otters of the 2nd Company recently demonstrated tactical mobility by airlifting 305 fully-equipped combat troops of the 16th Infantry from the forward area into the combat zone, a distance of 35 miles. This whole operation, part of Exercise " Call and Haul ", took only 80 minutes.

Subsequently, 10 Otters shuttled 20 tons of ammunition and supplies into an improvised " battlefield " landing strip in a 45-minute period.

The Otter carries a crew of two—over a ton of payload—lands in less than 600 feet.

The Otter—Designed and built by

THE DE HAVILLAND AIRCRAFT OF CANADA LIMITED

DOWNSVIEW, P.O. TORONTO, ONTARIO, CANADA

Operation Hourglass completes 1000 flight hours in 84 days

Allison Prop-Jet Powered Convair 340 Duplicates Commercial Flight Schedules — averages 12 hours per day in the air.

The record speaks for itself: 649 flights to 78 cities in 32 states · 1825 miles nonstop from Burbank to Indianapolis in 5 hours, 40 minutes · 12 hours fligh-time each day — for 84 days — with only line maintenance on engines and propellers · Routine cruise — 360 mph at 20000 feet · Specific fuel consumption well within specification from sea level to 20000 feet · Oil consumption — 10 gallons per engine in 1000 hours

Proving beyond doubt the operational readiness, flight dependability and superior economy of Allison Prop-Jet Engines and Aeroproducts Turbo-Propellers, Operation Hourglass clearly demonstrates why 11 airlines of the world have ordered 144 Allison Prop-Jet powered Lockheed Electras for medium- and short-range jet-age service.

ALLISON DIVISION OF GENERAL MOTORS, Indianapolis, Indiana

GM GENERAL MOTORS AIRCRAFT POWER

ALLISON PROP-JET POWER

FAR EAST
Zurich,
Switzerland's business and
tourist center
offers you direct flights
to all continents
and to the most important
cities of Europe
NEAR EAST
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Important link in World-Wide Air-Traffic

AD 2300

Marconi DOPPLER NAVIGATOR

FOR THE AIRLINE	FOR THE CAPTAIN	FOR THE CONTROLLER	FOR THE PASSENGER
...greater economy	...better navigation	...closer separation	...better service
The increased accuracy of navigation which the AD 2300 makes possible and the continuous flow of information which reveals instantly the effect of weather changes on the courses and speeds made good, enable pilots to achieve optimum flight paths. Self-contained navigation maintains your flexibility in operation and helps you to operate regularly and economically.	The AD 2300 series provides automatically and without reference to ground based aids: (a) Position in latitude and longitude. (b) Distance to go on a 'leg' or to destination on a 'great circle' or rhumb line track. (c) Wind speed and direction. (d) Ground speed. (e) Drift angle. (f) Steering information to Flight System or Autopilot to maintain the selected track.	The AD 2300 assists the pilot accurately to maintain his planned track. (The steering information can be fed directly into an Autopilot or flight system if required). It also enables the navigator to give ATC precise and reliable position reports and accurate E.T.A.'s and to keep them under constant review.	The advantages which the AD 2300 brings to the navigator, pilot and controller result in aircraft keeping more closely to their flight schedule and thus reducing frustrating and money wasting delays for the passenger, even when he is flying off the beaten track on routes where beacons and other ground based aids are few and far between.

Marconi's have been in quantity production with Doppler Navigators since 1954. Types AD 2000, 2100 are military types supplied to the R.A.F. and Commonwealth countries. The AD 2300 is the type designed specially for civil airlines.

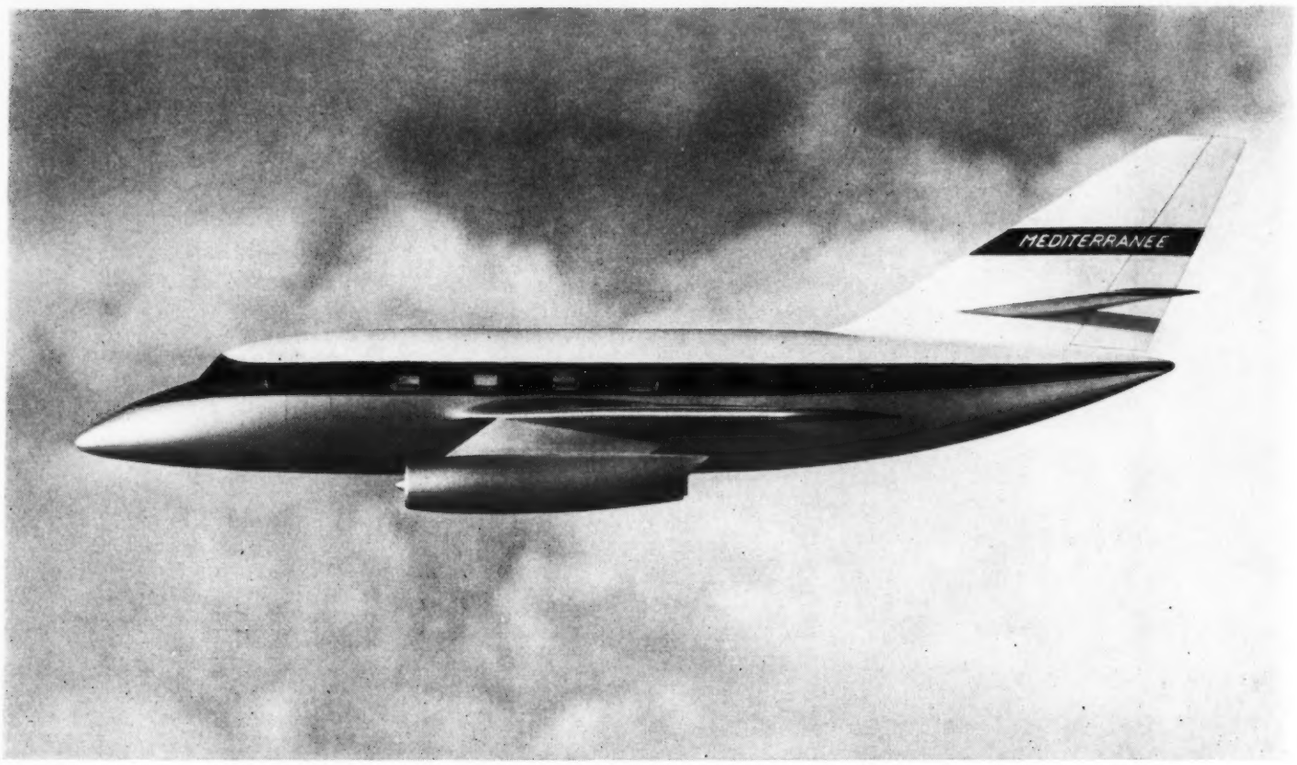
MARCONI

AIRPORT AND AIRCRAFT RADIO AND RADAR SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND

LA27

GÉNÉRALE AÉRONAUTIQUE MARCEL DASSAULT PRESENTS



"MÉDITERRANÉE"

COMMUNICATIONS AIRCRAFT FOR 8 PASSENGERS

TWO "FARANDOLE" JETS

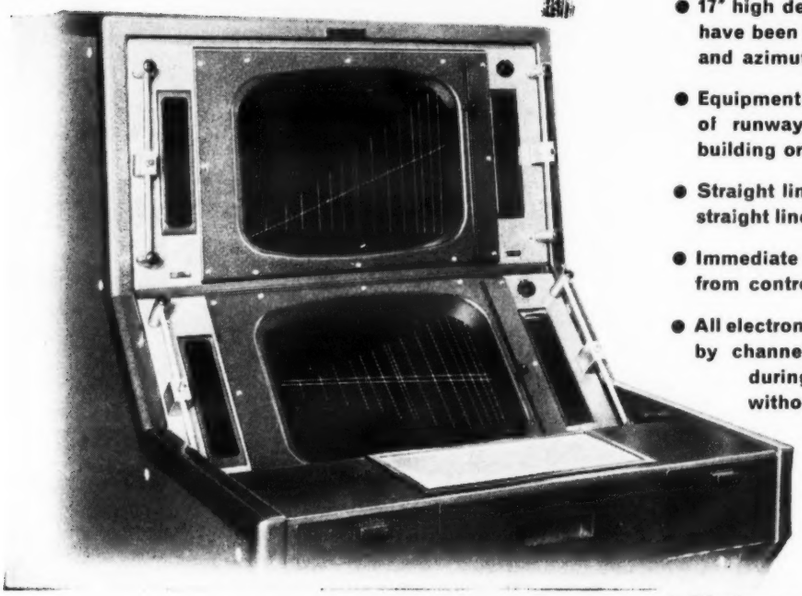
RANGE 1,550 miles

560 m. p. h.

Standard

Precision Approach

RADAR



- 17" high definition cathode-ray tubes have been incorporated for elevation and azimuth displays
- Equipment may be sited on either side of runway in either a permanent building or in turntable mounted hut
- Straight lines flown are presented as straight lines on the cathode-ray tube
- Immediate visual checking of system from controller's position
- All electronic units duplicated—stand-by channel may be fully checked during operation of equipment without interruption of service
- Test and monitoring equipment built-in
- Size and type of displays eliminate range switching
- Display consoles (1 to 4) may be situated up to 1½ miles from runway equipment

Type SLA 3

The SLA. 3 P.A.R. equipment has been ordered by:—
The Ministry of Supply
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The Royal Air Force
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Breguet 1001 Taon

Fiat G 91

Lockheed CL-329 Jetstar

Dassault Etendard VI

WORLD'S DESIGNERS SPECIFY ORPHEUS POWER

in fighters, strike aircraft, executive transports, and trainers

The Bristol Orpheus goes from strength to strength. This tough lightweight turbojet —with its simplicity of design and outstanding power-to-weight characteristics —provides designers all over the world with a unique solution to medium-thrust power plant problems.

Lightweight Bristol Orpheus turbojet dominant in increasing variety of roles

The current B Or 3 is rated at 4,850 lb and has the unparalleled thrust/weight ratio of almost 6:1. The B Or 4, the trainer version, is rated at 4,230 lb thrust; it is designed for the lowest possible fuel consumption and long life between overhauls.

Versions of the Orpheus power—or will power—the following aircraft:—

Lightweight fighters/strike aircraft

Folland Gnat	UK, INDIA, FINLAND
Fiat G 91	ITALY
Dassault Etendard VI	FRANCE
Breguet 1001 Taon	FRANCE
Hispano HA 300	SPAIN
Sud Aviation Baroudeur (alternative engine)	FRANCE
Aerfer Leone	ITALY

Utility transport

Lockheed CL-329 Jetstar *	US

Trainers

North American Model 249 (alternative engine)*	US
Fuji TIF 1	JAPAN
Folland Gnat Trainer	UK
Fiat G 91T	ITALY

Research aircraft

Short SB-5	UK

*Production versions of the Jetstar and North American Model 249 are being offered with Curtiss-Wright TJ 37 engines. The TJ 37 is a derivative of the Orpheus, jointly developed by Bristol and Curtiss-Wright.

MOST ADVANCED TURBOJET IN ITS CLASS

Orpheus development continues. The latest version, the B Or 12, has a still higher power/weight ratio, giving 6,810 lb thrust dry, over 8,000 lb with Bristol simplified reheat.

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Aero-Engines

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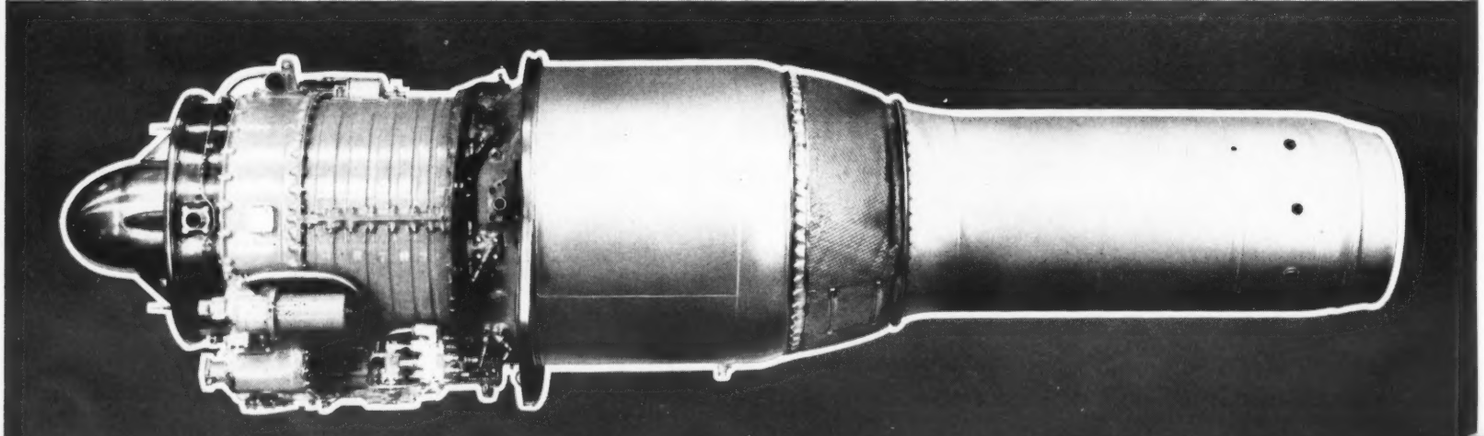

U.S. Air Transportation and Aircraft Industry in mid-February 1958

BY SCOTT HERSHEY, NEW YORK

The magnitude of the decline witnessed in airline shares lends support to the belief in some Wall Street circles that the worst may already be behind this group, at least marketwise. However, the impact of rising costs and the effects of increased competition will keep earnings under pressure in coming months.

The emergency fare relief granted the U.S. domestic airlines can be considered only more or less a palliative, since the rise in costs will persist, and there will be drains on cash and the transitional problems of the jet age are drawing nearer.

Despite a 13 percent gain in passenger traffic, the 12 domestic trunklines experienced a 56 percent drop in operating income during the first 11 months of 1957, and for all 1957 aggregate net fell to the lowest level since 1949, less than half of that of 1956. If there ever was a time when the airline industry needed financial strength, it is now.

While any relief is welcomed by the airlines, they did not exactly cheer the recent decision of the Civil Aeronautics Board which granted a boost of $1 per ticket, plus four percent, for an average increase of 6.6 percent, in passenger fares. Virtually every airline already has filed, or is about to file, increase requests ranging from 12 percent to 17 percent, since they regard the 6.6 percent temporary measure as entirely inadequate.

It was pointed out that the 6.6 percent increase, if applied during the first 11 months of 1957 would have resulted in a rise of some 23 percent in net operating income for the industry. Many industry leaders discount this, however, and regard it as over optimistic.

They point out that net operating income has been declining each year on a year to year basis for several years except in July 1957, and that a loss was incurred in the final quarter of 1957, as against an operating profit of $7.5 million a year earlier.

Industry leaders emphasize that in addition to these two points, fare adjustments do not eliminate their basic problem of rising costs and a seating capacity which outpaces the traffic and with no relief in sight.

C. R. Smith, president of American Airlines, told the New York Society of Security Analysts that the financial outlook for the airlines in 1958 depends almost entirely on the amount and timing of the fare increases for which the carriers have applied. He said that until adequate fare relief is obtained, not much better than break-even operations can be anticipated for the industry.

Stuart G. Tipton, president of the Air Transport Association, trade group of the scheduled airlines, declared that the 6.6 percent increase action by the C.A.B. "solved nothing, for it merely postpones again the need to face up to the financial requirements of the jet age."

"It took a *Sputnik* to shock the lag out of our missile program," Tipton said. "Will we have to wait for Aeroflot, the Soviet's airline, to overtake us before the Government appreciates the need for a privately financed U.S. commercial jet fleet."

Profits generally are still plunging, and hoped-for increases are still grounded. The sharp economy ax is beginning to be felt on a number of lines as they strive to reduce costs. And the airlines cost-cutting programs will be felt, of course, not only by the traveling public and airline employees, but also by the hundreds of firms that supply the airlines with a miriad of products for which there will be less demand so long as the economy drive continues.

But for the thousands of airline stockholders, the cost cutting program and extreme economies do seem to hold some hope that the downward trend in earnings may be checked.

The coming transition to jet aircraft has been the cause of some concern among holders of airline securities. Part of this concern is based on the unfavorable experience of Capital Airlines which, due to heavy break-in expense on their *Viscounts*, larger depreciation charges and interest costs, resulted in some deficit operations.

On the other hand, the reaction of the public to turboprops has been highly favorable. Also it appears that the rest of the industry may benefit from Capital's experience and make more preparations for the coming jet age.

Many Wall Streeters feel that the indicated economies of jet aircraft, looking beyond the introductory period, the longer life of jet aircraft and their appeal to the public should prove beneficial to the entire industry and thus to the industry's securities.

The airlines, of course, are not alone in the aviation world in their problems, since the aircraft manufacturers have a few of their own. The launching of the American satellite brought broad smiles to the faces of the scientists, military men and others responsible, and also brought a flurry of buying in securities involved in the overall missile and satellite area.

But as Bache and Co., a leading brokerage house observed, any company doing business with the Government must be viewed as speculative in nature. This observation was made while they were looking with favor on such companies as Lockheed and North American.

A Security and Industry Survey issued by Merrill Lynch, Pierce, Fenner and Beane also pointed out again that shares in the aircraft group are basically speculative. The survey added that intense competition and the rapid advances in product design also may affect positions of individual producers.

The increasing emphasis on missiles already is reflected in changed order and operating prospects, the survey adds, with benefits to some but reduced business for others in the field.

It is the opinion of some experts in the Street that, since reaction to Russian moves may stimulate some phases of the military program, coming months may see some lessening of aircraft industry uncertainties. This could mean that equities of well-rounded companies may perform at least average over the near to medium term.

The best situated at the present are issues representing diversified missile and aircraft activities. The price decline of past months has tended to reduce risks, although they still exist on a long term basis.

Briefs : A report to the American Stock Exchange shows that Atlas Corp. has purchased an additional 60,900 shares of Northeast Airlines and now holds 994,126 shares out of a total of 1,783,689... Douglas Aircraft reported net income for the fiscal year ended November 30th, 1957, of $30,665,000 or $8.28 a share, compared with $33,202,304 or $8.96 a share in the previous year... American Airlines reported unaudited preliminary net earnings of $9,094,000 exclusive of profit on disposal of property for the year ended December 31st, 1957. This is the equivalent, after dividends on the preferred stock, to $1.08 on the average number of shares of common stock outstanding during the period. Total earnings amounted to $10,886,000 or $1.31 a share on the common compared with $19,573,000 or $2.44 a share for the previous year.

INTERNATIONAL MEETINGS AND CONFERENCES

March 11th : IATA - Composite Agency Committee. Paris.

March 13th-14th : 2nd National Conference on Aviation Education. Washington.

March 13th-14th : IAS - Flight Propulsion Meeting (classified). Cleveland.

March 17th-20th : ARS/ASME - Joint Aviation Conference. Dallas, Texas.

March 17th-21st : AIChE - 4th Nuclear Engineering and Science Congress - American Institute of Chemical Engineers. Chicago.

March 17th-21st : NACE - Symposium on Aircraft Corrosion Problems - National Association of Corrosion Engineers. San Francisco.

March 17th-21st : AGARD - 3rd colloquium of the combustion and propulsion panel. Palermo.

March 18th : IATA - Medical Committee. Washington.

March 18th-19th : Conference on Extremely High Temperatures (over 30,000 °K) AF Cambridge Research Center, Bedford, Mass.

March 18th-19th : First Interservice and Industry Symposium on Guided Missile Training Equipment. Naval Ordnance Laboratory, Silver Spring, Maryland.

March 23rd-29th : Esso International Congress. Baden-Baden.

March 24th : IATA - Air/Sea Working Group. Paris.

March 24th-27th : IRE - National Convention and Radio Engineering Show. New York.

March 24th-29th : 4th International Instrument Show. London.

March 25th-29th : ASSEE - 7th Electrical Engineers Association Exhibition. London.

April : IATA - Legal Committee.

April 1st-3rd : ASME - Division of Instruments and Regulators Conference. University of Delaware. Newark, Delaware.

April 5th : British Interplanetary Society - " Problems of Handling Large Missiles " by F. R. F. Taylor. London.

April 8th-10th : 8th International Symposium, Electronic Waveguides - Microwave Research Institute of Polytechnic Institute of Brooklyn. New York.

April 9th : ICAO - Rules of the Air, Air Traffic Services and Search and Rescue Division. Montreal.

April 9th-19th : ITU/CCITT - Committee of the General Plan for the Development of the International Network. Rome.

April 10th-11th : ATS - Annual Meeting of the Aeronautical Training Society. Washington.

April 11th : British Helicopter Society - " Powered Lift Systems " by Ch. H. Zimmerman (NACA). London.

April 14th-15th : ASME - Maintenance and Plant Engineering Conference. Pittsburgh, Pa.

April 14th-17th : ASME - Design Engineering Conference. Chicago.

April 14th-17th : RECMF - 15th Annual Radio Component Show, organized by the Radio and Electronic Component Manufacturers' Federation. London.

April 16th-19th : AHS - 14th Annual National Forum - American Helicopter Society. Washington.

April 16th-25th : RCEEA - Instruments, Electronics and Automation Exhibition - Radio Communication & Electronic Engineering Association. London.

Recommendations of I.C.A.O.'s Fourth Regional Air Navigation Meeting

The Fourth Regional Air Navigation Meeting of the International Civil Aviation Organization for the European-Mediterranean Region, which opened in Geneva at the end of January, completed its work on February 21st.

The following summary of the Meeting's final communiqué supplements the article entitled " The Air Navigation Angle " on page 220 of the present issue.

Rules of the air and air traffic control

The meeting reviewed the existing plan for the airways in the lower airspace (below 20,000 ft.) and extended it to take account of changes introduced since the last regional meeting five years ago. It recommended that full air traffic control should be provided on all routes insofar as the radio navigation aids situation makes this possible.

A basic plan was developed for the new route-network in the upper airspace (above 20,000 ft.) for jet aircraft, and it was agreed that this plan should be introduced step by step as experience of jet aircraft increased. It was recognized that all civil and military operations in the Region should be closely coordinated and controlled. Two possible systems of control were recommended, a fixed airways network or a flexible system of " predetermined routes " which could be adjusted according to meteorological conditions, traffic conditions (to avoid congestion over certain dense areas of air traffic) and military operations.

It was also recommended that the lower airways network should be fully set up by the middle of 1960, and that the implementation of the system for jet aircraft in the upper airspace should be completed by the end of 1961.

Communications and radio navigation aids

In the fields of communications and radio navigation aids stress was laid on the use of VHF static-free techniques. In this connection the Meeting recommended that more than 300 VOR installations should be provided in the Europe-Mediterranean Region.

With the ever increasing speed of modern aircraft, it has become essential to permit pilots and air traffic controllers on the ground to communicate with conversational ease and with a minimum of distraction due to atmospheric static or interference from other transmissions.

The provision of ground radar as a tool for the air traffic controller has been widely recommended not only for application in major terminal areas, but also along many of the more densely flown routes where the problems of control can be most acute.

Airports

The Meeting listed and recommended the development of over 160 aerodromes required for international air services in the Region.

The length of runway needed for a particular turbojet aircraft varies greatly with the take-off weight at which it is operated. This is dependent on such factors as stage distance, location of alternate aerodromes relative to regular aerodromes, weather conditions, etc. For each hour of flight, a jet aircraft consumes approximately 6½ tons of fuel, so that the difference in the take-off weight for a flight of one hour and of six hours is of the order of 32 tons. The difference in runway length can be as much as 6,000 ft.

The Meeting marked the first occasion on which sufficient data were available to estimate approximate runway lengths required for planning purposes at each aerodrome in the Region.

Other detailed recommendations called for the provision of visual ground aids, including approach, runway, taxiway and obstruction lighting in accordance with I.C.A.O. specifications, and for the provision of rescue and fire fighting equipment at aerodromes, including boats or amphibious vehicles where the approaches or take-offs are over water.

Meteorology

The imminent introduction of turbojet aircraft in the Region caused more than normal attention to be paid to the upper air observation network. It was agreed that rather than increasing the density of the observation network, it would be of particular value to increase the frequency of observations at existing stations. Accordingly, the Meeting recommended that four radiowind observations per day be made at 56 stations in the Region. Some fourteen of these stations are already making four observations per day.

An up-to-date list was prepared of the aerodromes which are required to possess fully equipped meteorological offices for pre-flight meteorological service, and to provide flight information centres with the meteorological data needed for transmission to aircraft in flight. A total of 67 of these offices will be required to have available special weather charts for atmospheric levels of about 30,000 ft.

★

The recommendations of the Regional Air Navigation Meeting will now be studied by the I.C.A.O. Air Navigation Commission in Montreal and submitted to the 21-member Council of I.C.A.O.

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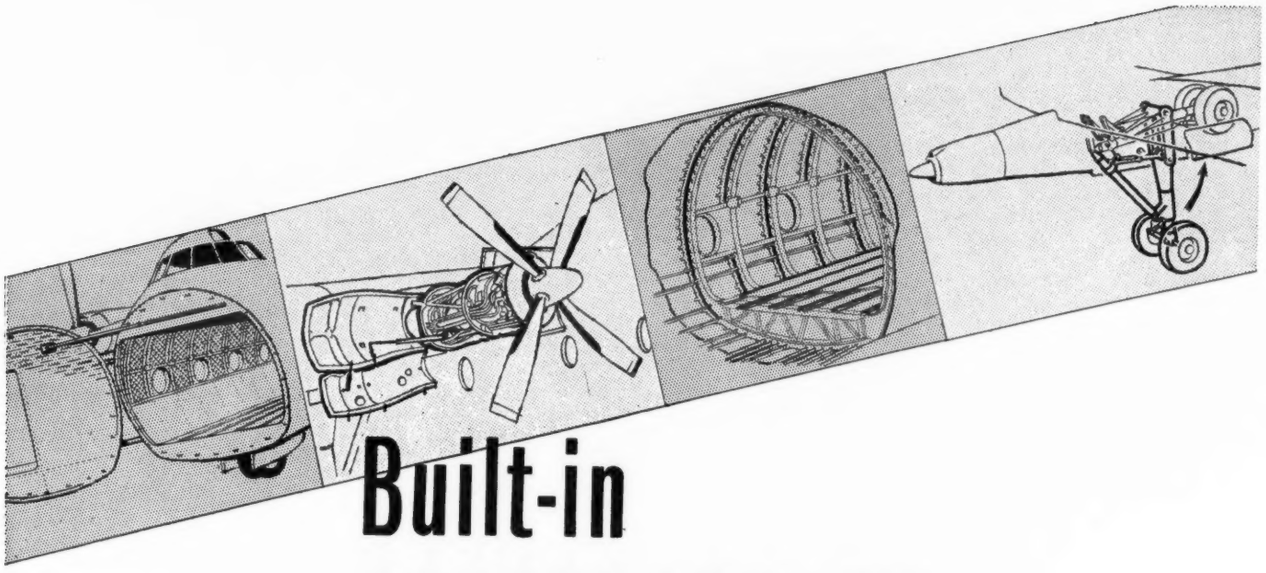
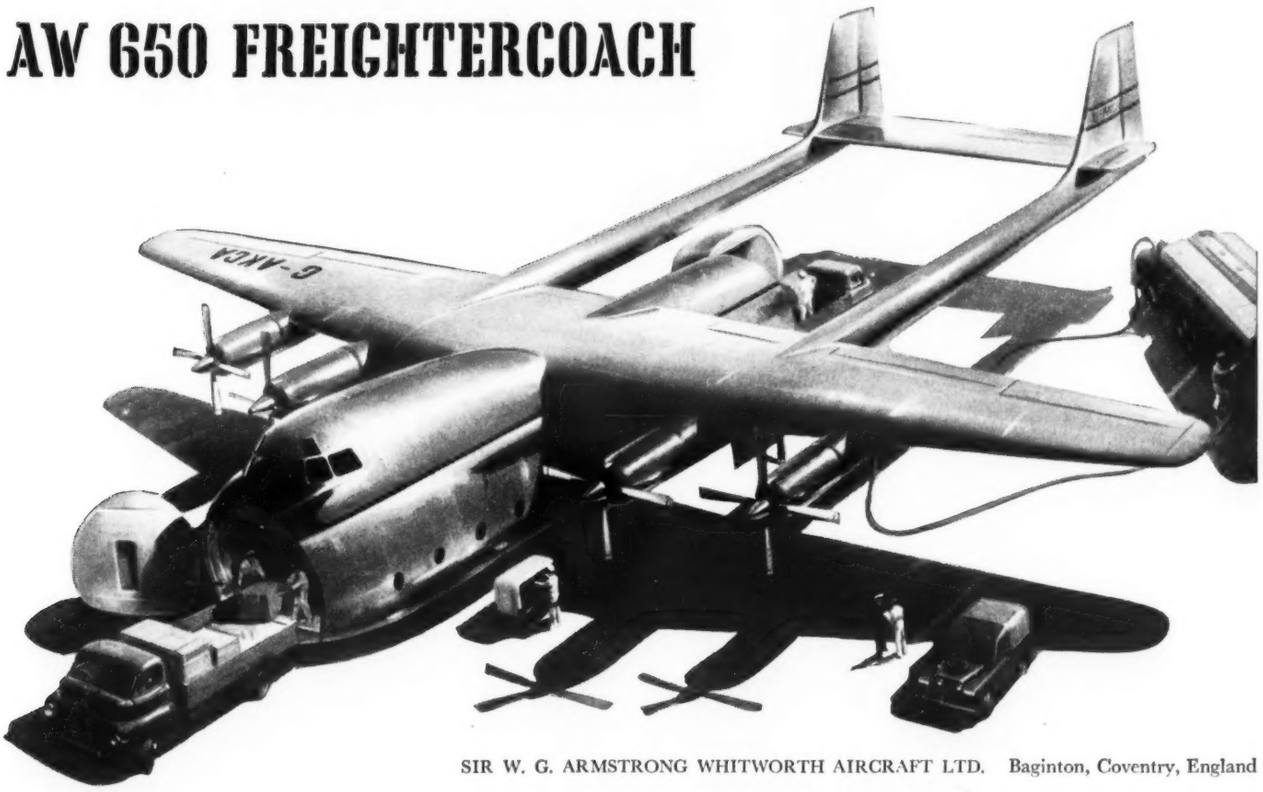


Built-in DEPENDABILITY

Backed by 40 years' experience of aircraft engineering, the AW.650 pressurised turbo-prop Freightercoach is designed to give dependable service on the airfreight routes of the world. Fully tested, simple but robust pressurised structure, proven components and accessories, and the world-renowned Rolls-Royce Dart power plants combine to ensure long overhaul life and minimum line maintenance. The built-in dependability of the AW.650 Freightercoach, and its outstanding adaptability, make this aircraft one of the brightest prospects for airfreight service in the 1960's.

AW 650 FREIGHTERCOACH



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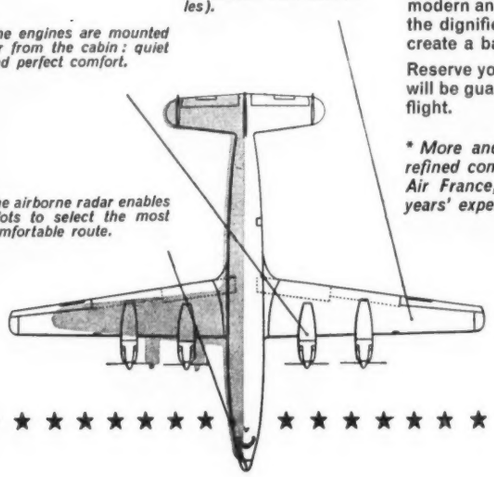
The engines are mounted far from the cabin : quiet and perfect comfort.

The airborne radar enables pilots to select the most comfortable route.



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The Super Starliner's luxurious interiors have been designed by Air France for your pleasure and your comfort. They are definitely modern and reflect the best French taste : the gay and restful colours, the dignified materials and the care given to each detail combine to create a background of elegance and comfort . . .

Reserve your seat now aboard an Air France Super Starliner and you will be guaranteed a pleasant, fast and restful journey . . . an excellent flight.

** More and more travellers—one more every minute—appreciate the refined comfort, attentive service and incomparable cuisine offered by Air France, whose proverbial regularity is the result of thirty-eight years' experience in the service of progress.*

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The F11F-1F has unsurpassed maneuverability at extremely high altitude and excellent handling characteristics for its very high Mach number capabilities. This, plus its ability to operate from carriers and small airfields, qualifies the F11F-1F as the world's best air superiority fighter.

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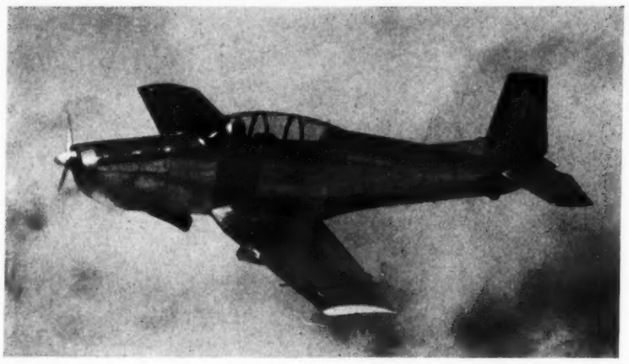

P3 **Trainer for the Swiss Air Force**

Equipped for: Elementary training, Altitude flying, Acrobatics, Instrument flying, Night flying

With training armament for: Machine gun practice, Rocket practice, Bombing practice

P3 **is today's most versatile trainer in its class, for the rational training of military pilots, from first flight to jet fighter**

- **Shortens training time**
- **Reduces training costs**
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NAPIER THERMAL IGNITION ROCKET ENGINES are light and compact high performance power units employing HTP and kerosene as oxidant and fuel. This propellent combination and principle of operation have been proved completely safe and reliable over many years of service.

The Napier team of propulsion engineers is one of the most experienced in the country engaged on the development of liquid propellent rocket engines and supersonic ram jets for both guided weapons and piloted aircraft. Among the outstanding developments of this team are the NRE 17 missile engine (illustrated) and the Double Scorpion aircraft rocket engine, now in production for the Royal Air Force, which recently established the World's Aircraft Altitude Record of 70,310 ft.

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THE NRE 17 MISSILE ENGINE

An extremely simple unit specifically designed for production in large quantities. The NRE 17 incorporates the latest developments in uncooled combustion chambers and exhaust nozzles. It can be started or stopped at will, repeated start-stop sequences in flight being entirely reliable at any altitude. Similar Napier engines, developed under contract to the Ministry of Supply, have propelled many of Britain's experimental guided weapons on the Woomera Rocket Range, Australia.

NAPIER *Rocket Engines*

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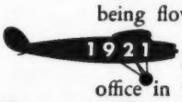
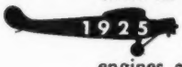
1919 - KLM is founded at The Hague, Holland, - the *oldest* air company in the world still flying under the same flag.

KLM inaugurates the Amsterdam-London flight which is the *oldest* air route in the world still being flown by the same carrier.



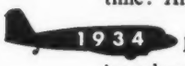
KLM opens the *first* air traffic booking office in the world.



KLM is the *first* to make use of air-cooled engines and all-metal propellers.

1927 - KLM makes the world's *first* intercontinental charter flights.

KLM opens the *longest* air route of that time: Amsterdam-Jacarta.



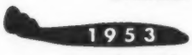
KLM, as the *first* airline outside the U.S.A., introduces all-metal Douglas DC-2 and wins the London-Melbourne Air Race. Two years later KLM is the first European company to buy the DC-3.

1943 - KLM, as first non-U.S.A. carrier, orders the Lockheed Constellation.

KLM, though heavily shattered by the war, is the *first* European airline to open a post-war North Atlantic service.

1948 - KLM is the first European airline to buy the Convair Liner.

1950 - KLM is the first European airline to be specially authorized by the U.S. Government to overhaul aircraft of U.S. air companies.



KLM is the world's first airline to operate the turbocompounded Lockheed Super Constellation.

1956 - KLM is the *first* carrier outside the U.S.A. to order the jet-engined Douglas DC-8 and the turboprop Lockheed Electra.

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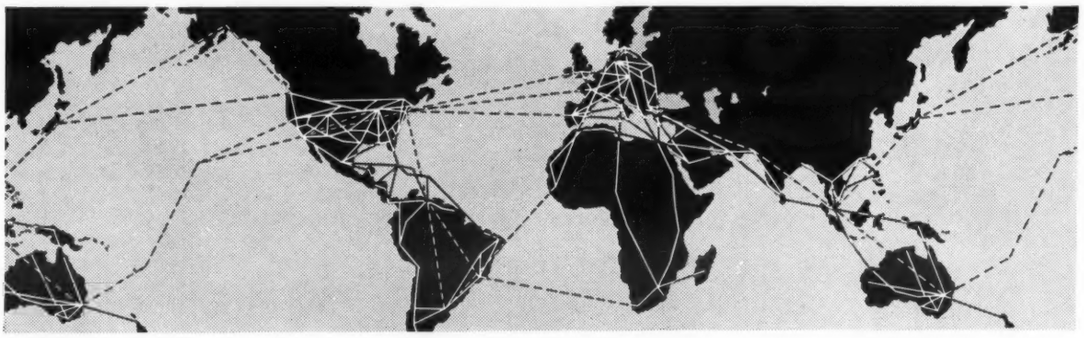
(1) Requires the large turbo-jet powered airplane, flying at high cruise speeds and high altitudes for long periods.



(2) SHORT-TO-MEDIUM HAUL... involves a varied pattern with many intermediate stops—with lower flying altitude for shorter periods—and between large, medium and small cities... some with small airports and with traffic varying from very heavy to very thin.

(2) Requires a highly specialized, flexible machine of just the right size and carefully tailored to fit "short-to-medium haul" needs. Emphasis must be on economics since airline unit operating costs are inherently higher in this area.

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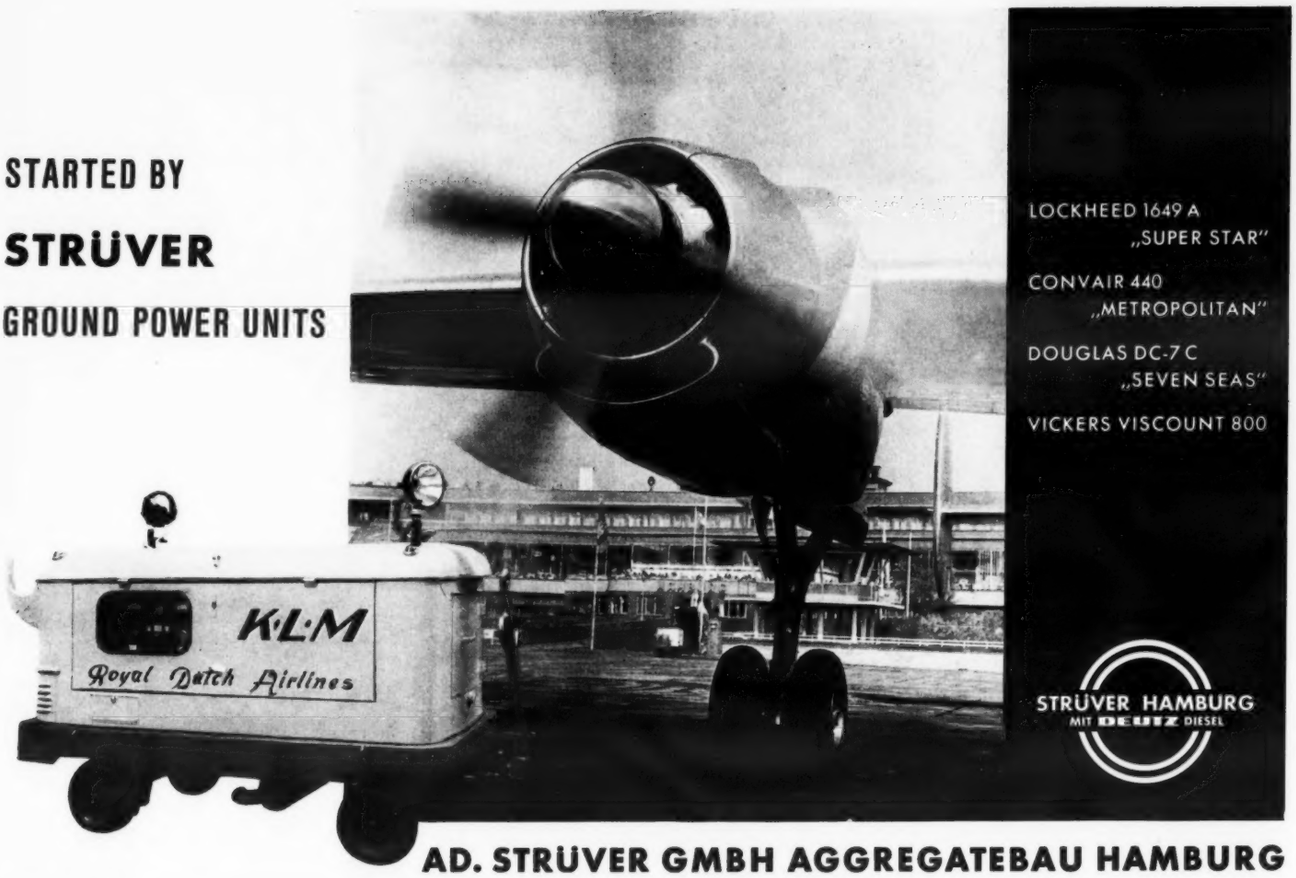

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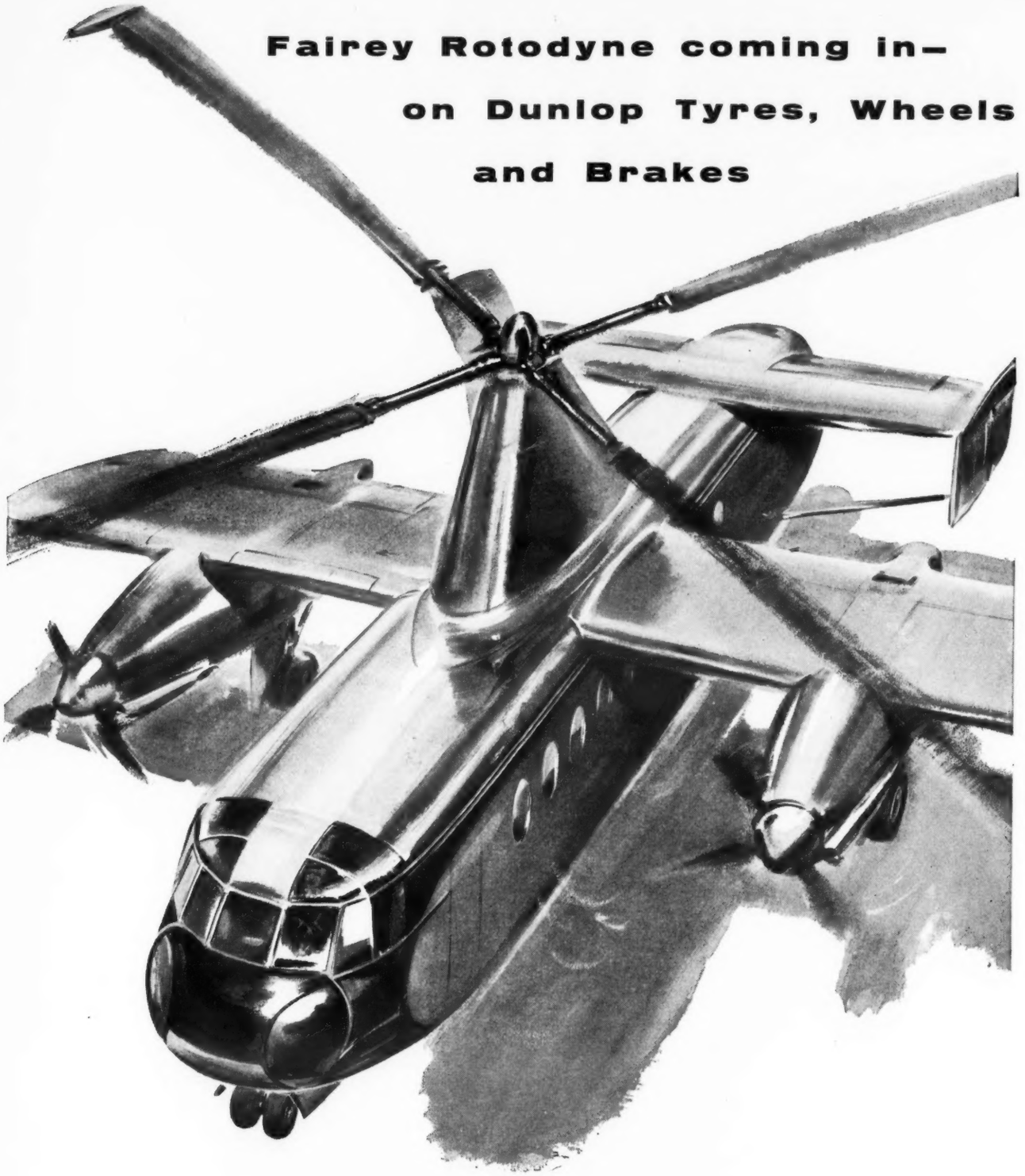

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European Transport Problems

Round about the middle of 1957 the European railways announced the introduction of impressive new trains, to be known as Trans Europe Express trains and to connect 70 cities, with a degree of comfort not hitherto achieved. At the end of January 1958 the writer had the opportunity of sampling the new T.E.E. trains. Within 24 hours he had to travel from Bonn for talks in The Hague and Brussels, and be back in Bonn the following evening. Flying was out of the question, as the airline timetables did not permit so much to be done in so short a time.

Tickets were issued by a Bonn travel agency, who recommended that seats should be reserved. This, however, was impossible, as 24 hours notice had to be given. The writer travelled by ordinary train from Bonn via Cologne to The Hague, spent the night in the latter city and completed his business there the following morning. Shortly before noon the T.E.E. train from Amsterdam, bearing the attractive name of Edelweiss, drew into The Hague station, on the way to Zurich, via Brussels and eastern France. A really comfortable train of Swiss production, drawn by a diesel locomotive; if I am not mistaken, three passenger cars and a restaurant car. The conductor spoke fluent Flemish . . . but no French, German or English. I went along to the dining car, only to be told that no meals could be served for another hour, after the Netherlands-Belgian frontier; until then the kitchens were "sealed" for Customs purposes. The halt at Rozendaal, the frontier station, was scheduled as only a few minutes, but there had been a heavy fall of snow, and the T.E.E. was held up for some 75 minutes. Finally we moved on, only to find that the whole electricity supply had failed, putting heating, air conditioning, lighting and kitchen out of service. The train crew maintained that the fault could not repaired until the train reached its destination in Zurich.

My second experience was not much different. Coming from Brussels, I picked up the T.E.E. train for Cologne in Liège. Again the same degree of comfort, though this time the train was of German construction. Again I went along to the dining car, which included not only a restaurant but also an imposing bar. Supper? Impossible: the kitchen was again "sealed" until beyond the Belgian-German frontier, one hour away. That's how it is with European frontiers . . .

As will be seen, even the railways have their difficulties. In this congested Europe of ours, with its nearly 300 million inhabitants, any attempt to cross a frontier seems to be regarded with suspicion! And the airlines are surprised when overseas travellers shake their heads over all these formalities or—to avoid all such inconveniences—prefer to travel by car. That way they at least see something of the countryside.

*

In the present issue the Editors have attempted to discover from the fragmentary documentation available how many Europeans are real airline customers. The *Institut du Transport Aérien* in Paris deserves credit for having worked out an estimate for 1955: of the total European population of 293 millions, only 500,000, or roughly 1.3 percent, can be regarded as real airline customers, according to this source. Even if this figure had increased by 50 percent, to 750,000 persons, by 1957 it is still ridiculously low. Something can and must be done here, if the European airlines hope to fill the large turbine-powered aircraft which they will have in service from 1960 onwards. The problem is not only one of fares; psychological considerations also play their part, not to mention the question of flight schedules and the inconveniences caused by frontier formalities.

*

But the T.E.E. trains demonstrate how central European railway authorities have got together to run similar equipment to 70 cities, changing crews at the frontiers. The railways here appear to have succeeded in forming a real pool. The European airlines, however, have so far not got beyond good intentions and bilateral agreements. As long as governments continue to have the last word in air transportation, nothing better than piecemeal improvements can be expected—despite all the large-scale international conferences.

*

What is the position as regards air freight in Europe? The following small example will serve as illustration.

In December 1957 the writer flew to Paris for the N.A.T.O. conference, accompanied by his wife. She of course had forgotten to bring a dress which she absolutely needed for a particular evening. The dress was delivered to Swissair in Geneva in the morning and arrived punctually in Paris at midday, not however in the hands of the owner but at Orly Airport, where the Customs had taken charge of it. As my wife refused to spend two hours driving to Orly and back and certainly was not prepared to pay Customs dues on a dress which she had already worn, the dress went back to Geneva. Altogether a most useful transaction. The bill for air freight to Paris and back was 48 Swiss francs, or around $12.

All of which shows that in Europe the same applies to both inanimate freight and live passengers; both suffer from excessive red tape. And if the airlines do not make an effort to appoint an "air transport czar" with full powers (on the same lines as the United States missiles "czar" or Russia's air transport chief), who can enlighten the men round the conference table on what is possible and what is not possible in air transport, all efforts will be in vain.

*

N. B. The introduction of a new feature on "Automation" in this issue may appear somewhat ironical. On the one hand the call is for simplification and acceleration, on the other we hold fast to the habits of the old stage coach days. Perhaps we can also "automatize" our civil servants . . . *EEH*

* *

*

Can all those seats be filled?

In mid-January representatives of twelve major European airlines met around the Air Research Bureau's conference table at The Hague[1] to review the events of 1957 and to take a look at the future. From the subsequently issued communiqué it can be accepted that they were not pessimistic about the general picture: "Delegates noted with satisfaction that a substantial increase in European passenger traffic had taken place, but expressed concern at the fact that the availability of hotel accommodation will not keep pace with future requirements". The full 1957 operating results are not yet available but, on the basis of the 1952—1956 figures, the European scheduled air traffic operators have no cause to regard the future with anxiety. A simple calculation, based on the I.A.T.A. published individual figures for the fifteen principal airlines, who between them handle over 90% of European traffic, presents the following picture:

Combined operating results for 15* European Airlines in intercontinental and European traffic over the period 1952-1956

	1952	1953	1954	1955	1956
Passengers carried: (thousands)	5,283	6,368	7,331	8,694	10,453
Revenue passenger/km: (millions)	6,386	7,547	8,689	10,258	12,183
Capacity tonne/km: (millions)	1,265	1,490	1,763	2,045	2,358
Revenue tonne/km: (millions)	830	956	1,078	1,258	1,476
Load factor:	65.6%	64.2%	61.1%	61.4%	62.7%
Personnel:	73,174	75,845	79,816	88,073	97,105

* Aer Lingus, Aero O/Y, Air France, Alitalia, B.E.A., B.O.A.C., Iberia, K.L.M., L.A.I., Lufthansa, Sabena, S.A.S., Swissair, T.A.I., U.A.T.

Measured by any standard it is clear that the volume of European air traffic was almost doubled in the period from 1952 to 1956, and this was a particularly noteworthy achievement when compared to the American carriers whose total revenue passenger/km increased only from 25,100 to 44,400 million over the same period[2].

Evidence that the A.R.B. Conference in the Hague did not view the future with complacency was provided by the announcement of a study programme which is currently being carried out on the operating costs for intra-European traffic in 1957. Full consideration must be given also to the views of the Chairman of the Hague Conference, General I. A. Aler, K.L.M.'s President, as expressed in an article in the K.L.M. House Magazine "De Wolkenridder" of January 25th, 1958: "...A third factor of importance is a marked decrease in international passenger traffic, due to the general unsettled state of the world economy. This recession was also apparent in K.L.M. during the final months of 1957". Not only K.L.M. is affected by the other unfavourable factors which General Aler mentioned in this connection; as a result of developments in Indonesia K.L.M. has been forced to cancel five valuable services between Amsterdam and Jakarta, and to recall over 300 employees to Holland. But have not other European carriers also suffered similar setbacks in the last few years? If Egypt quarrels with Europe, or North Africa decides to go its own way, if there are crises in Syria or frontier incidents in the Yemen, the European airlines must bear their share of the consequences.

But to return to the subject of 1957 operating results, the figures available up to the present time appear to be satisfactory. Some examples are: *Lufthansa* carried 386,000 passengers (229,670 in 1956) with 3,248 revenue freight tonnes (1,990) and a passenger load factor of 57% (47%); *Sabena:* 700,000 passengers (526,000); *S.A.S.:* 1,396,000 (1,179,000); *Swissair:* 992,911 passengers (773,956 in 1956), revenue tonne/km 104,235 (73,201); *U.A.T.:* 140,000 passengers (125,000).

Although these figures are encouraging at the same time warning signals from the United States demand attention. Unlike the European carriers the American airlines estimated operating results for 1957 have been available for some time, and the first financial results are now being released. In spite of the improved operating results, these figures reveal a financial result which is far from encouraging. For the period January to October 1957 United States domestic traffic brought a 39.2% drop in profits compared to the equivalent period in the previous year, and in view of these findings the financial reports of the European carriers are awaited with considerable interest.

Who uses European air transport?

Economic analyses of air traffic normally begin with close scrutiny of the passenger business as, in both Europe and the United States, passenger volume provides some four-fifths of the total operating revenue. A percentage comparison of the 1956 operating results for the fifteen European carriers quoted earlier, broken down into Passenger, Freight and Mail traffic, provides an illustration of this point:

Percentage breakdown of Passenger, Freight and Mail traffic in 1956

	Passengers and excess baggage	Freight	Mail
Aer Lingus	86.1	11.0	2.9
Aero O/Y	88.4	8.9	2.7
Air France	76.0	17.5	6.5
Alitalia	85.4	9.6	5.0
B.E.A.	86.0	10.0	4.0
B.O.A.C.	69.7	18.6	11.7
Iberia	94.4	3.4	2.2
K.L.M.	70.4	25.4	4.2
L.A.I.	78.2	15.0	6.8
Lufthansa	78.8	12.7	8.5
Sabena	70.1	23.6	6.3
S.A.S.	80.0	14.3	5.7
Swissair	78.8	16.0	5.2
T.A.I.	77.1	17.4	5.5
U.A.T.	70.4	25.4	4.2

A second factor, which has been underlined by the Institut du Transport Aérien, Paris (I.T.A.)[3], is that Americans provide a vital percentage of European passenger traffic. As one delegate to the Strassburg Conference wryly commented: "Everything in the garden would be lovely if the European airlines were operating in the States". In other words, any attempt to forecast the total European airlines passenger volume must automatically take into account the American passenger potential.

[1] The Air Research Bureau, Brussels, was established as a study organization in 1952; members are now Aer Lingus, Air France, Alitalia, B.E.A., Finnair, Iberia, Icelandair, K.L.M., Lufthansa, Sabena, S.A.S. and Swissair.

[2] Air Transport "Facts and Figures" 1957, published by A.T.A.

[3] "Comparaison des Potentiels de Passagers Aériens des Etats-Unis et de l'Europe", a study prepared by I.T.A. for the second meeting of the European Civil Aviation Conference (Strasbourg).

"Passenger volume" climbing; the "untapped potential" waves good-bye.

Population figures

The burning question which then arises is the size of the West European passenger potential. Different authorities have arrived at widely varying totals in their estimates of total population. For example, for the one year 1954, the following figures have been published: The I.C.A.O. Bulletin 1956, No. 6 —total population of the 19 Strasbourg Conference States—313 million; the Air Research Bureau, in a comparison between the development of air transport in Europe and U.S.A. —330 millions; "Statistical Data" by the Council of Europe—268 millions.

Similar contradictions appear in most other European statistics and studies of European economy, defence and other spheres adopt widely differing standards as a basis. There are some 27 different national authorities handling statistics without any form of lateral coordination or contact. At I.C.A.O.'s 4th European Regional Navigation Conference in January 1958 delegates were required to accept as a basic document for further studies an I.C.A.O. review of aircraft movements which dated back to August 1956, and which had been compiled on facts assembled in early 1956. Despite urgent requests by the Conference Office, the individual states' representatives found themselves unable to revise these figures to show the position in 1957.

For the present purpose it is therefore necessary to accept one of the conflicting figures for the total West European population in 1954, and this has been taken as 330 million. The population of the United States is taken from the Statistical Abstract of the United States as 162 millions.

Tickets sold - or actual customers ?

How many air traffic customers does this human reservoir provide? In 1954 the population of the United States was 162 millions. In the same year U. S. airlines recorded over 35 million "passengers". Europe had a population of 330 million in 1954 and recorded a total of over 7 million "passengers". It does not however follow that these figures can be interpreted as meaning that every fifth American or every forty-fifth European has been won over to air transportation; the total figures for air "passengers" include many travellers who make three, four or more journeys by air each year, while the bulk of the population still continues to utilize cheaper methods of transportation. In the field of air transport only the higher-income brackets can be considered, and the question is thus—how high an income?

The I.T.A. study of American and European passenger potential, quoted earlier, takes as a basis for air travellers in the year 1954, an absolute minimum annual income of $4,300.

In 1954, 28.9 million Americans (including families) belonged to this "privileged" income bracket. The I.T.A. study found that in practice however only approximately 7 million individual Americans could be reckoned as having made one or more journeys by air. The remaining 28 million "passengers" quoted in the A.T.A. statistics, are therefore seen not as flesh-and-blood human beings, but only the number of tickets sold for the several journeys carried out by the 7 million individuals.

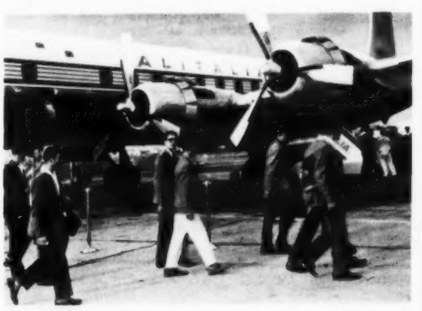
An efficient feeder service is essential for intercontinental traffic: A *Sabena* Sikorsky S-58 at Brussels-Melsbroek Airport.

The European airlines carry their flags to all corners of the world

A *Scandinavian Airlines System* DC-7 about to depart on an Arctic circle flight from Europe to the U.S.A.

Prominent Africans arrive in Brazzaville by *Air France*.

On April 5th, 1957, *Swissair* inaugurated its scheduled Zurich–Tokyo service.



Italian emigrants fly by *Alitalia* to Johannesburg.

Among the palm trees: A *B.O.A.C. Britannia* lands at Tripoli.

The Dutch colony in Los Angeles celebrated Prince Bernhard's birthday by "spring cleaning" a K.L.M. *Super Constellation*.

The old guard and the new generation: *German Lufthansa* Junkers Ju 52 and Lockheed *Super Constellation* at Hamburg-Fuhlsbüttel Airport.

For Europe it is difficult to arrive at any comparative figures based on accurate statistics. The I.T.A. study considered that of a total 293 million Europeans (15 countries), only 3.8 million people could be reckoned as falling within the $4,300 income bracket, that is 1.3% of the total. The total number of Europeans who make one or more journeys by air each year is put by I.T.A. at an estimated 500,000.

Certainly it may be argued that these figures are too low, especially in regard to Europe where, in round figures, an income bracket of $2,500 would compare more realistically with the American figure of $4,300. However, compared to a system of computing passenger traffic on the basis of tickets sold—albeit the only practical method open to the carriers—this method is useful in that it provides direct information on the customer potential and shows how far down the income scale the airlines can go in canvassing for new customers. Such considerations were the basis for the introduction of tourist class services, and may later lead to the introduction of third class services, in order to exploit the lower income passenger potential.

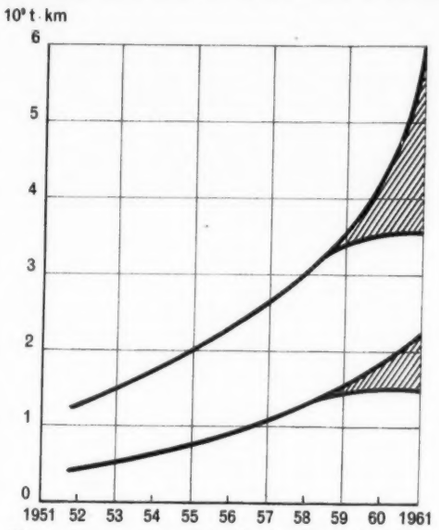
However, for the present these speculative figures cannot be taken as a basis for air traffic statistics. In practice the number of tickets sold must be accepted, and a comparison made between capacity ton/miles and revenue ton/miles to discover whether the airlines can reckon with an economically satisfactory load factor for both the present fleets and those on order.

At the beginning of the article a comparison was made of the increase of revenue tonne/km for 15 European airlines over the years 1952 to 1956. A comparison of the total fleet strengths of the same fifteen carriers is given in the table on the left.

Aircraft fleet strengths of 15 European airlines

	1952	1956	1961
Class 1: DC-8, 707, 720	—	—	(62)
Class 2: Caravelle Comet IV	—	—	(37)
Class 3: Armagnac, Super Constellation (1049, 1649) DC-7 Britannia Electra Vanguard	3	56	(194)
Class 4: Constellation DC-6 Stratocruiser Canadair IV DC-4 Viscount	189	255	(250)
Class 5: Convair Liner (240, 340, 440), F-27 Friendship Heron Nord 2500 D.H. Ambassador HD 32, Viking, Bristol 170 Languedoc	97	108	(105)
Class 6: Scandia DC-3 Junkers Ju 52 Consul Lodestar	236	216	—
Capacity tonne/km (in millions)	1,265	2,358	(6,000)

In this table the aircraft fleet is divided into six classes according to performance. The estimated figures for 1961 have been arrived at on the basis of the present fleet strengths (with allowance for retirements) and aircraft on order for delivery by 1961. It is anticipated that the aircraft in class 6 will be have been retired by that date.



The upper curve represents the development of total annual traffic capacity (in tonne/kilometers) for 15 European airlines, based on the figures available for the period 1952-1956 and considering the aircraft due for entry into service by 1961. The lower curve represents the traffic capacity of these airlines for European internal services. The shaded portions indicate the percentage of jet aircraft.

Snow on London Airport: On the left the rear of a *Sabena* Convair *Metropolitan*; centre a B.E.A. Vickers *Viscount*; right a de Havilland *Heron*.

Will the European carriers fill their aircraft?

As the accompanying graph shows, in 1961 the fifteen European airlines will have an annual available load capacity of 6,000 million tonne/kilometers, i. e. 2,200 million for domestic services and 3,800 million for intercontinental traffic.

It will be no easy matter to boost the 1956 registered figure of 1,500 million revenue tonne/kilometers for passengers, freight and mail to a total of 3,600 million in order to ensure that, in 1961, the carriers will have an economic load factor of 60%. But this does not appear to be by any means impossible so long as energetic efforts are made to maintain the yearly percentage increases in revenue tonne/kilometers at the same rate as for the last three years.

The outlook is not unfavourable. The total population of the western world has been increasing rapidly over the last few years. For example, the United States Census Bureau gives a figure of 172.8 million inhabitants at the end of 1957 compared to 162 million in 1954. Western Europe also will probably show a considerably increased total compared to the figure of 337 million in 1956, quoted in the Statistical Abstract. An indication that

incomes in Europe have increased considerably over the last four years can be indirectly read from an analysis published in the American business-man's magazine "Fortune"; the December 1957 issue featured an enthusiastic article on the European economic miracle under the title "Europe's New Age of Abundance" which gave the following statistics for the years 1953—1957: per capita consumption up 20%, industrial investments up 50%, industrial production up 25%. And, providing no economic crisis arises, these figures promise a considerable increase in the standard of living in the coming years.

With a corresponding increase in air traffic volume? Atlantic traffic, which comprises a large proportion of the European airlines business—approximately 60% of all European traffic is derived from outside Europe—has increased eight-fold since the end of the war (1946—105,000 Atlantic passengers, 1952—447,956 and 1956—834,790). Over the same period the shipping companies have only increased their passenger figures some 2½ times (1946—405,000, 1956—1,000,000). It is not difficult to draw the conclusion that any additional increase in Atlantic traffic will bring the greatest benefit to the airlines. The European share of the trans-Atlantic air traffic in the immediate post-war period was approximately 25%, but in 1955 had reached a figure of 46.5%, that is almost one-half.

Thanks to the numerous connecting services, European internal traffic reflects any increase in Atlantic traffic. Over the last five years traffic in Europe has increased more sharply than in any other continent. The Air Research Bureau confirms this fact with the following comparison table[4]:

Passenger/kilometers (in millions)

	1952	1953	1954	1955	1956	Increase 1952–1956
Europe	2,650	3,220	3,780	4,680	5,700	115%
U.S.A.	20,000	23,600	26,780	31,740	36,100	81%
World total	40,020	46,360	52,220	61,200	70,900	77%

What can then be done to give a further boost to Europe's total volume of traffic?

One obvious suggestion is a reduction in fares. The Atlantic services have had good successes with the Tourist Class fares, first introduced in 1952, and a further step is being taken in this direction with the introduction on April 1st, 1958, of a third class fare scale showing a considerable reduction on the second class charges. But whether the introduction of an Economy Class inside Europe would have worthwhile results is another question. The airlines fleet availability would pose no problems for the introduction of such a service but, for the time being, the European airline planners are apparently not convinced of the economic advantages of third class services.

One step which could most certainly be taken to boost the volume of traffic would be a greater coordination in timetables between the various traffic centres of Western Europe. Many travellers, especially business men, who today find it more convenient to use the railways, might then be persuaded to travel by air.

*

Obviously forecasts and proposals, from whatever source they may come, are subject to the usual reservations, as was pointed out by Sir William P. Hildred, Director General of the International Air Transport Association, in his year-end review: "Governments willing and general economic conditions permitting, 1958 should be a good year for the world's airlines . . ." Nobody can say whether an economic slump is in the offing, or whether governments will come to terms with the present inflationary tendencies. But, slump or boom, due heed should be paid to the warning which Air France's President Hymans offered his European colleagues at a press conference in mid-January: "Standardization of the European airlines' fleets will greatly simplify the cooperation and coordination which, in view of the coming jet traffic, appears to be more urgent than ever."

[4] "Comparison between the development of air transport in Europe and in the United States 1957".

. . . and tomorrow 150-passenger jet airliners

The first production model of the Boeing 707-120 *Jet Stratoliner* for P.A.A. which is now undergoing intensive flying trials for C.A.A. certification. This aircraft is scheduled to enter regular passenger service early in 1959. The 707-120 is equipped with new type noise suppressors which break up the jet exhaust into smaller gas streams without appreciable loss of power. The world's airlines have placed orders for a total of 151 Boeing 707s.

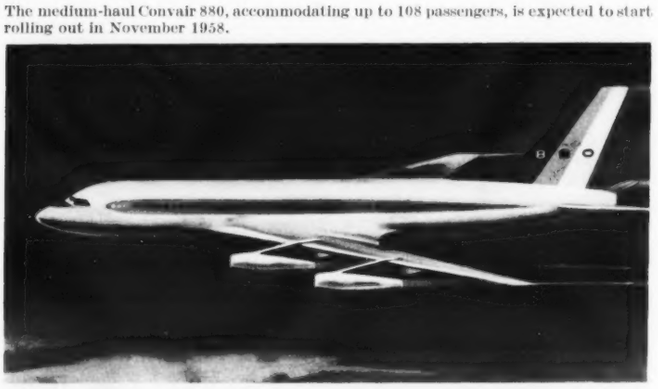
Aircraft for Tomorrow's Airline Fleets

A model of the DC-8. The first production model of this aircraft is now approaching completion.

The first production model Boeing 707-120, destined for P.A.A.'s fleet, made its first flight in December 1957.

The medium-haul Boeing 720 jet transport, with accommodation for 130 passengers, is now under development.

The medium-haul Convair 880, accommodating up to 108 passengers, is expected to start rolling out in November 1958.



Which aircraft will form the basis for the next decade in air transportation? In answer to this question, of critical interest to both the carriers and their passengers, the following survey discusses the two most important and competing categories of aircraft which must be considered: i. e. *jet and turboprop transports.* Consideration of the development position for the planned or already existing V.T.O.L. and S.T.O.L. aircraft must be left to a later issue.

Since *Interavia's* October 1955 review of the western world's short and medium-haul aircraft, followed by the March 1956 study of the new long-range types, the total order book has become considerably fatter, and now* stands at:

Jet transports: 151 Boeing 707s; 11 Boeing 720s; 134 Douglas DC-8s; 63 Convair 880s; 25 de Havilland *Comets*; 35 Vickers VC. 10s; 23 Sud-Aviation *Caravelles.*

Turboprop transports: 144 Lockheed *Electras*; 77 Bristol *Britannias* (of which 24 are on order for the R.A.F. or Ministry of Supply); 383 Vickers *Viscounts* (total number ordered, including those already delivered, of both Series 700 and 800); 40 Vickers *Vanguards*; 111 Fokker *Friendships* (including both Fokker and Fairchild).

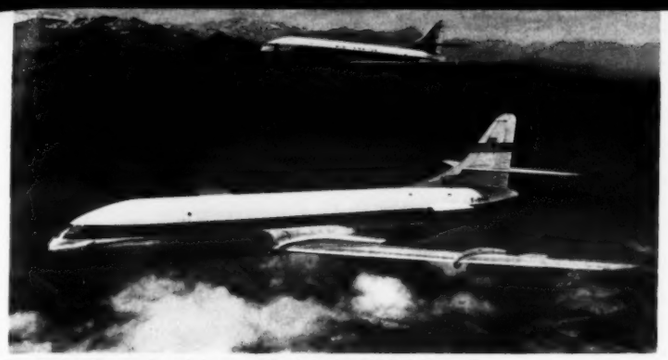
Ignoring for the moment the impressive Russian production programme, and the recently settled question of B.E.A.'s medium-haul jet fleet, the aircraft which have already been ordered for entry into service within the next few years now amount to a total of *442 jets and 755 turboprops.*

In the face of these impressive figures the suggestion must naturally arise that the individual airlines fleet requirements are now well covered and that the funds available to both the large and smaller carriers are now fully committed? It is clear that not all the types and versions which are being offered on today's market can have the success which the manufacturers hope for. This fierce competition at least guarantees that tomorrow's civil air traffic will be operated with the most modern and economic equipment. On the other hand the wide range of already developed types now on offer to meet the precise requirements of the individual carriers promises excellent possibilities for coping with the rapid increases in traffic figures which are forecast. One result is that many aircraft manufacturers have been compelled to offer specialized versions of basic types to each potential customer, but these cannot all be covered in the tables accompanying this article.

The wide variety of aircraft on offer can be grouped into the following categories, which will dominate the scene until supersonic transports become available:

* Firm orders at February 8th, 1958.

Ordered for B.O.A.C., the Vickers VC. 10 long-haul jet transport will have accommodation for 135 passengers.



The first and second prototypes of the twin-jet SE.210 *Caravelle*.

The de Havilland *Comet 3*, predecessor of the 4 Rolls-Royce Avon RA. 29 engined *Comet 4*.

Group 1: Long-range jet transports with maximum cruising speeds of over 500 knots and payloads of 15 to 20 tons over the full range, seating capacity 100 to 170 passengers.

Group 2: Large medium-haul jet transports with max. cruising speeds of over 500 knots and payloads of 12 to 14 tons with seating for 80 to 130 passengers.

Group 3: Smaller medium-haul jet transports with max. cruising speeds around 500 knots, payloads 9 to 11 tons and seating capacity for 70 to 100 passengers.

Group 4: Medium and long-haul turboprop transports for cruising speeds of 300 to 350 knots, payloads 10 to 14 tons and seating capacity for 75 to 135 passengers.

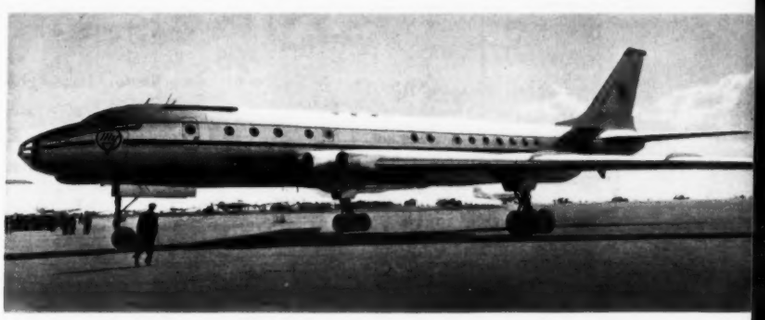
Group 5: Short and medium-haul turboprop transports for cruising speeds of around 250 knots with payloads of 4 to 6 tons.

Group 1 includes the Boeing 707, Douglas DC-8 and the Vickers VC. 10; while Group 2 covers the Boeing 720 and Convair 880. Typical Group 3 aircraft are the Bristol 200 and de Havilland 121, developed to meet the B.E.A. specification, and the Russian Tu-110; this group has special characteristics which are discussed below. Group 4 embraces such aircraft as the Bristol *Britannia,* Vickers *Vanguard,* Lockheed *Electra,* and the Ilyushin Il-18 *Moskva.* Falling into Group 5 are the Handley Page *Dart Herald,* Vickers *Viscount* and Fokker *Friendship.*

*

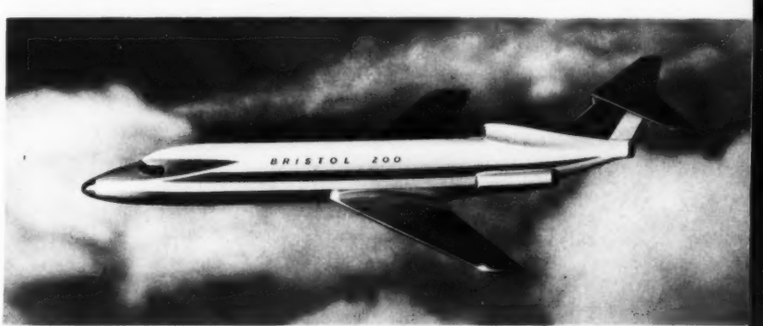
Aircraft of the Group 1 category are still attractive propositions for the financially stronger carriers. Quite recently B.O.A.C. has placed a £ 60,000,000 order for the delivery of 35 Vickers Armstrongs VC. 10 long-range jet transports, in addition to the 15 Boeing 707-420s already on order. According to B.O.A.C. statements, the 135-ton VC. 10 will be brought into service in the mid-60s chiefly on the Corporation's African, Australian and Far Eastern routes; a decisive factor was undoubtedly the VC. 10's good take-off and landing characteristics to meet the carrier's requirements for these routes. With airframe refinements and increased power, the same aircraft will be utilizable on the North Atlantic services. In any case the VC. 10 is not expected to make its first flight until the late summer of 1961; delivery to B.O.A.C. probably will not begin until 1963, at a time when the airlines will already have had some three years experience of operating jet aircraft.

The Group 2 large medium-haul jet aircraft have aroused interest in a considerable number of airlines. General Dynamics Corporation has received one order alone for 30 Convair 880s from T.W.A.; Delta has ordered 10, Transcontinental 4, R.E.A.L. 4 and Capital 15. The Boeing 720 has also made an impact on the market, with a firm order

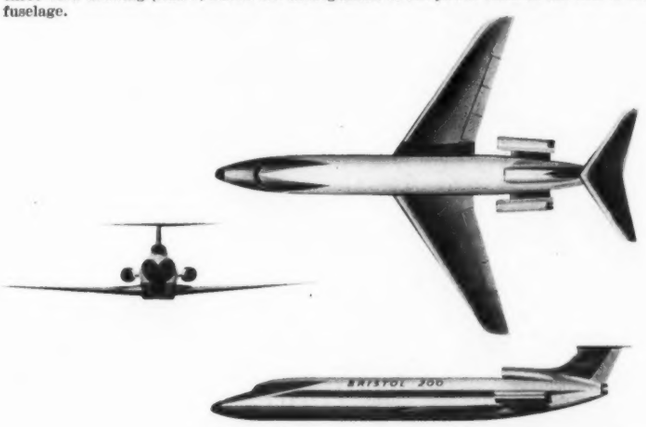


A new standard version for Aeroflot: the Tupolev Tu-110 with four Lyulka jet engines.

...and, already in regular service: the twin-jet Tupolev Tu-104, seating 50 passengers.



The Bristol 200 is a projected medium-haul transport to the B.E.A. specification. The three-view drawing (below) shows the arrangement of the power units at the rear of the fuselage.



Also with three jet engines: de Havilland's projected type DH.121 is designed to the B.E.A. specification.

Long-Range Jet Aircraft

Type	Vickers VC.10	Boeing 707-120 Jet Stratoliner	Boeing 707-220 Jet Stratoliner	Boeing 707-320 Intercontinental	Boeing 707-420 Intercontinental	Douglas DC-8 Domestic	Douglas DC-8 Domestic	Douglas DC-8 Intercontinental
Country of Origin	GREAT BRITAIN	U.S.A.						
Engines (number and type) Max. sea level static thrust	4 × R.-R. *Conway* 4 × 21,000 lb.	4 × P&W JT3C-4 4 × 12,500 lb.	4 × P&W JT4A-3[3]) 4 × 15,500 lb.	4 × P&W JT4A-3 4 × 15,500 lb.	4 × R.-R. *Conway 505* 4 × 16,500 lb.	4 × P&W JT3C-6 4 × 13,000 lb.	4 × P&W JT4A-3[4]) 4 × 16,000 lb.	4 × P&W JT4A-3[4]) 4 × 16,000 lb.
Span Overall length Wing area	140 ft. 158 ft. 2,800 sq.ft.	130 ft. 8 in. 144 ft. 6 in. 2,433 sq.ft.	130 ft. 8 in. 144 ft. 6 in. 2,433 sq.ft.	142 ft. 4 in. 152 ft. 11 in. 2,892 sq.ft.	142 ft. 4 in. 152 ft. 11 in. 2,892 sq.ft.	139 ft. 8 in. 150 ft. 6 in. 2,758 sq.ft.	139 ft. 8 in. 150 ft. 6 in. 2,758 sq.ft.	139 ft. 8 in. 150 ft. 6 in. 2,758 sq.ft.
Max. gross weight Max. take-off wing loading Max. payload (space limited) Max. fuel capacity Max. landing weight	~300,000 lb. ~107 lb./sq. ft. ~35,000 lb.[1]) — —	248,000 lb. 102 lb./sq.ft. 42,400 lb.[2]) 17,398 U.S.gals. 13,478 U.S.gals. 175,000 lb.	248,000 lb. 102 lb./sq.ft. 42,400 lb.[2]) 17,398 U.S.gals. 13,478 U.S.gals. 175,000 lb.	296,000 lb. 102.7 lb./sq.ft. 42,000 lb.[2]) 22,920 U.S.gals. 21,200 U.S.gals. 195,000 lb.	296,000 lb. 102.7 lb./sq.ft. 42,000 lb.[2]) 22,920 U.S.gals. 21,200 U.S.gals. 195,000 lb.	264,500 lb. 95.6 lb./sq.ft. 33,620 lb.[1]) 37,910 lb.[2]) 17,600 U.S.gals. 189,000 lb.	265,000 lb. 96 lb./sq.ft. 33,620 lb.[1]) 37,910 lb.[2]) 17,600 U.S.gals. 189,000 lb.	287,500 lb. 104 lb./sq.ft. 35,930 lb.[1]) 37,910 lb.[2]) 21,615 U.S.gals. 190,500 lb.
Passenger capacity (tourist class) Passenger capacity (first class) Total freight volume	135/152 108 —	150 106/121 1,600 cu.ft.	150 121 1,600 cu.ft.	162 131 1,700 cu.ft.	162 131 1,700 cu.ft.	144/171 118 1,415 cu.ft.	144/171 118 1,415 cu.ft.	144/171 132 1,415 cu.ft.
Max. cruising speed Recommended cruising speed (at average cruising altitude when marked *) Average cruising altitude	540 kn — 40,000 ft.	514 kn — —	525 kn — —	525 kn — —	516 kn — —	500 kn 492 kn*) 30,000 ft.	509 kn 493 kn*) 30,000 ft.	509 kn 495 kn*) 30,000 ft.
C.A.R. take-off field length for max. gross weight at sea level (I.C.A.N.) C.A.R. landing field length for max. landing weight at sea level (I.C.A.N.) Typical still-air range (with payload given)	— — —	9,860 ft. 6,300 ft. 2,860 nm (35,965 lb.)	7,000 ft. 6,300 ft. 2,900 nm (35,965 lb.)	8,900 ft. 6,400 ft. 4,100 nm (34,965 lb.)	9,100 ft. 6,400 ft. 4,450 nm (34,965 lb.)	9,860 ft. 6,680 ft. 3,420 nm (33,620 lb.) 3,195 nm (37,910 lb.)	7,300 ft. 6,630 ft. 3,530 nm (33,620 lb.) 3,290 nm (37,910 lb.)	8,760 ft. 6,690 ft. 3,900 nm (35,930 lb.) 3,790 nm (37,910 lb.)

Remarks:
[1]) First class.
[2]) Tourist class.
[3]) 707-520 version similar to the 707-220, but with four Rolls-Royce *Conway 505*.
[4]) The Domestic and Intercontinental versions of the DC-8 are also available with Rolls-Royce *Conway 10*.

for 11 aircraft for U.A.L.; but in addition U.A.L. has announced plans to acquire a fleet of 51 Boeing 720s by 1965. The accompanying table shows that the "Seven-Twenty" is a jet transport of the same size as the Boeing 707-120 *Jet Stratoliner,* and retains many of the latter's characteristic design and dimension features. With increased fuel capacity both the Convair 880 and the Boeing 720 could be utilized on trans-Atlantic services.

On the medium-haul market are the Bristol *Britannia 301* (four Bristol *Proteus 755s*) and the Vickers *Vanguard* (four Rolls-Royce *Tynes*).

The B.E.A. specification for a medium-haul jet type is worthy of note, emerging from a long period of study as a typical compromise solution to the present-day requirements, and bringing, inter alia, a drastic reorganization of Great Britain's aircraft industry. What B.E.A. wants is a multi-jet type for at least 80 passengers, cruising speed over 500 knots, for stages of 350-870 nautical miles with full payload, relatively short take-off and landing characteristics, and a gross weight of approx. 50 tons. Three designs—the Avro 740, Bristol 200 and de Havilland 121—were on the short list, with the considerably larger Vickers VC.10 as an outside possibility. For over 18 months Bristol has been working on the 200 design, originally with four jets, but now with three only, as illustrated herewith; Avro and de Havilland had also decided on a three-engined design. Only the de Havilland design follows the exact B.E.A. specification, and the two other companies, with an eye to the European and American markets, decided that their designs must be more flexible than the pure B.E.A. specification required. To avoid competition in this export market, Bristol and Avro (Hawker-Siddeley) have planned to pool their interests, dropping the Avro project, with Hawker-Siddeley holding a 65 percent interest and Bristol 35 percent in a proposed new joint company to develop the 200. The Hawker-Siddeley group would be responsible for develop-

A long and successful career is also forecast for the Lockheed *Electra* medium-haul turboprop transport, powered by four Allison 501-D13s.

Medium-Range Jet Aircraft

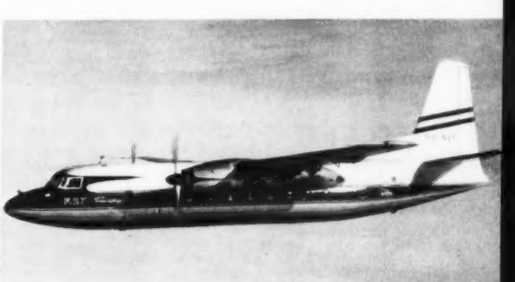
Type	Bristol 200	De Havilland 121	De Havilland *Comet 4*	De Havilland *Comet 4B*	Sud-Aviation SE.210 *Caravelle*	Tupolev Tu-104A	Tupolev Tu-110	Boeing 720	Convair 880
Country of Origin	GREAT BRITAIN				FRANCE	SOVIET UNION		U.S.A.	
Engines (number and type)	3×R.-R. RB.141 (or 3× Bristol Olympus 550)	3×R.-R. RB.141	4×R.-R. *Avon RA.29*	4×R.-R. *Avon RA.29*	2×R.-R. *Avon RA.29*	2×Mikulin/ Zubetz AM-3	4×Ljulka	4×P&W JT3C-7	4×GE CJ 805-3
Max. sea level static thrust	3×12,000 lb. (or 3×13,000 lb.)	3×12,000 lb.	4×10,500 lb.	4×10,500 lb.	2×11,000 lb.	2×14,850 lb.	4×~11,000 lb.	4×12,000 lb.	4×11,200 lb. gross
Span	91 ft.	—	115 ft.	107 ft. 9 1/8 in.	112 ft. 6 in.	114 ft. 10 in.	123 ft.	130 ft. 10 in.	118 ft. 4 in.
Overall length	121 ft. 6 in.	—	111 ft. 6 in.	118 ft.	105 ft.	123 ft.	125 ft. 8 in.	134 ft. 6 in.	124 ft. 2 in.
Wing area	—	—	2,121 sq.ft.	2,059 sq.ft.	1,579 sq.ft.	2,024 sq.ft.	~2,100 sq.ft.	2,433 sq.ft.	2,000 sq.ft.
Max. gross weight	120,000 lb.	125,000—130,000 lb.	156,000 lb.	152,500 lb.	90,400 lb.	150,000 lb.	~170,000 lb.	203,000 lb. / 185,000 lb.	186,500 lb. / 178,500 lb.
Max. take-off wing loading	—	—	73.6 lb./sq.ft.	74 lb./sq.ft.	57.2 lb./sq.ft.	74 lb./sq.ft.	~81 lb./sq.ft.	83.5 lb./sq.ft. / 76.1 lb./sq.ft.	93.5 lb./sq.ft. / 89 lb./sq.ft.
Max. payload (space limited)	21,000 lb.	21,000-24,000 lb.	16,800 lb.[1] / 19,360 lb.[2]	21,968 lb.	19,840 lb.	16,535 lb.	26,455 lb.	33,000 lb.	26,320 lb.
Max. fuel capacity	—	—	8,990 Imp. gals.	7,890 Imp. gals.	4,070 Imp. gals.	7,480 Imp. gals.	—	13,478 U.S.gals. / 10,092 U.S.gals.	12,670 U.S.gals. / 10,770 U.S.gals.
Max. landing weight	—	—	113,000 lb.	118,500 lb.	86,000 lb.	—	—	165,000 lb.	132,800 lb.
Passenger capacity (tourist class)	99	110	76	99	—	70	100	130	108
Passenger capacity (first class)	79	78	60	84	80	50	50/78	110	84/88
Total freight volume	—	—	545 cu.ft.	545 cu.ft.	608 cu.ft.	—	—	1,235 cu.ft.	863 cu.ft.
Max. cruising speed	520+ kn	520+ kn	—	—	—	—	—	520+ kn	534 kn
Recommended cruising speed (at average cruising altitude when marked *)	—	—	433 kn*)	462 kn*)	400 kn*)	430 kn*)	430 kn	—	484 kn*)
Average cruising altitude	—	—	40,000 ft.	23,500 ft.	30,500-36,000 ft.	~25,000 ft.	32,800—39,400 ft.	15,000—40,000 ft.	35,000 ft.
C.A.R. take-off field length for max. gross weight at sea level (I.C.A.N.)	6,000 ft.	—	6,380 ft.	6,500 ft.	5,500 ft.	5,000 ft.	—	6,700 ft.	7,150 ft.
C.A.R. landing field length for max. landing weight at sea level (I.C.A.N.)	—	—	3,520 ft.	6,260 ft.	3,200 ft.	3,900 ft.	—	5,500 ft.	6,000 ft.
Typical still-air range (with payload given)	260—1,480 nm	260—865 nm	2,600 nm (16,800 lb.) / 2,340 nm (19,360 lb.)	2,000 nm (21,968 lb.)	1,250 nm (19,840 lb.)	1,735 nm	1,680—1,800 nm (26,455 lb.)	2,865 nm (22,000 lb.) / 2,240 nm (33,000 lb.)	3,900 nm (15,000 lb.) / 2,800 nm (26,320 lb.)

Remarks:
[1]) First class.
[2]) Tourist class.

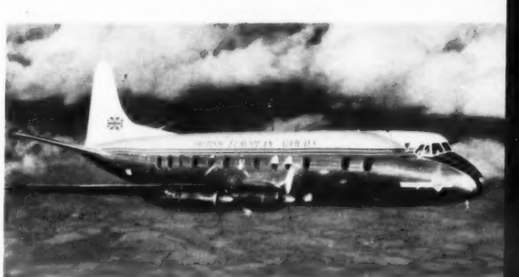
ment of the airframe and Bristol for the entire equipment; the 200 will be offered with alternative powerplants—either three Rolls-Royce RB. 141 (a smaller version of the *Conway*) by-pass jet engines, or three Bristol *Olympus 550* (also built under licence by Curtiss Wright as the *Zephyr*). The Bristol 200 would be capable of operating route stages of from 260 to 1,480 nautical miles. Reports indicate that Pan American is showing interest in the aircraft, offered in this case with either *Olympus/Zephyr* or Pratt & Whitney J57 power units; this version could be of considerable value in the carrier's European and Caribbean networks as feeders for the DC-8 and Boeing 707 services.

The de Havilland 121 will succeed the *Comet 4B* (already on order for B.E.A.) on the company's production lines and will ensure a continuation of the de Havilland/Rolls-Royce cooperation. Another new company proposed to take over production of the DH. 121 is Aircraft Manufacturing Co. Ltd.—AIRCO, with de Havilland putting up 67½ percent of the capital, Hunting Aircraft 22½ percent and Fairey 10 percent.

Britain's Ministries of Supply and Transport clearly favoured the Bristol Hawker-Siddeley project, as the amalgamation of these two groups would result in a bigger industrial potential and, by no means



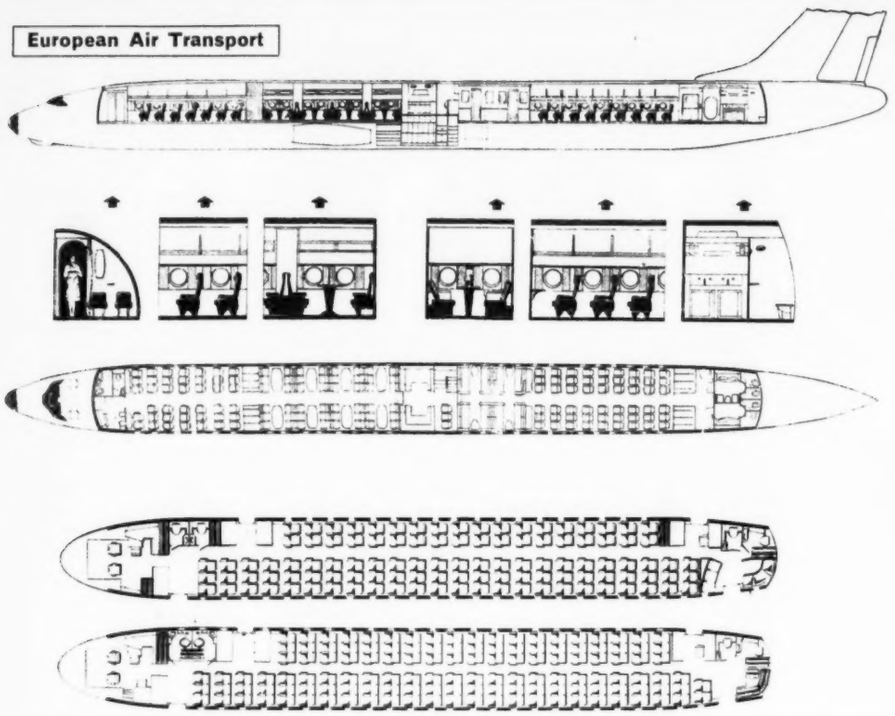
A short-haul transport, the Fokker F.27 *Friendship* (two Rolls-Royce *Darts*) is also being built under licence by Fairchild in the United States.



The Vickers *Viscount 800* (four Rolls-Royce *Darts*) is the latest, but certainly not the last, addition to this successful family.

A contemporary from the Russian stable: the Ilyushin Il-18 *Moskva* with four Kusnetsov NK-4 engines.

Designed for the Soviet Union's domestic routes, the Antonov An-10 *Ukraina* has four Kusnetsov-Ivchenko jet engines.



Seating layout (left) and view of the forward passenger compartment in the Tupolev Tu-114 *Rossiya*.

Seating layouts for the 108-passenger (above) and 131-passenger versions of the Douglas DC-8. Right – the modern practical furnishings of the 108-seat version.

the least consideration, greater resources to cope with possible export orders for the new medium-haul type.

It must be stressed that, as already indicated in the foregoing grouping of aircraft, these new medium-haul types are in an entirely different weight class than the Boeing 720 or Convair 880. This means markedly lower ton-miles capacity; the chief problem facing both B.E.A. and the manufacturers has been to achieve a favourable power loading ensuring short take-off distances and good rate of climb to cruising altitude. The possibility of operating from smaller airfields and economic block speeds have been the two decisive factors in the design of the new medium-haul types. The British argued that mounting of the power units at the rear of the fuselage had the principal advantage of making possible an aerodynamically clean wing; uninterrupted high efficiency slats and flaps would offer shorter take-off and landing distances as well as the lowest possible drag in high altitude cruise. These considerations have also influenced the engine positioning in the larger VC. 10.

*

The tables herewith give a side-by-side comparison of technical data for the various types under discussion. Exact comparison of performance of the aircraft listed is not possible as the take-off distances and ton-miles capacities are based on varying criteria. This applies particularly to the Soviet Union's jet and turboprop aircraft. It will be noted that several Russian types (Tu-110, Il-18 *Moskva*) follow the western pattern of development, and that Russia has also been able to undertake the construction of the giant Tu-114 *Rossiya* turboprop transport. Over the long hauls of the eastern network stages this aircraft will probably fulfil the same tasks as the west's Boeing 707 and Douglas DC-8.

Jet and Turboprop firm orders at February 8th, 1958

Type	Total	Ordered by:
Jet aircraft		
Boeing 707	151	Air France 17. Air India 3. American 30. BOAC 15. Braniff 5. Continental 4. Cubana 2. Lufthansa 4. PAA 23. Qantas 7. Sabena 4. TWA 34. Varig 3.
Boeing 720	11	UAL 11.
Convair 880	63	Capital 15. Delta 10. REAL 4. Transcontinental 4. TWA 30.
Douglas DC-8	134	Delta 8. Eastern 20. JAL 4. KLM 8. National 6. Olympic 2. PAA 21. Panagra 4. SAS 7. Swissair 3. TAI 2. TCA 6. Trans Caribbean 1. UAT 2. United 40.
de Havilland *Comet 4*	25	BEA 6. BOAC 19.
Sud-Aviation *Caravelle*	23	Air France 12. Finnair 3. SAS 6. Varig 2.
Vickers VC. 10	35	BOAC 35.
Turboprop aircraft		
Bristol *Britannia*	77	100 Series: BOAC 15. 250 Series: RAF 20. MoS 3. 300 Series: Aeronaves 2. BOAC 18. CPAL 6. Cubana 2. El Al 3. Hunting-Clan 2. Northeast 5. MoS 1.

Type	Total	Ordered by:
Fairchild *Friendship*	63	Avensa 5. AREA 1. Bonanza 6. FAL 4. Mackey 2. Northern Consolidated 3. Piedmont 12. Quebecair 2. Southwest 3. WCA 6. Wheeler 2. Wien Alaska 3. Non airlines 14.
Fokker *Friendship*	48	Aer Lingus 7. Braathens 3. KLM 2. PAL 2. Sabena 12. TAA 6. TAE (Spain) 3. Non airlines 13.
Lockheed *Electra*	144	Aeronaves 3. American 35. Ansett-ANA 4. Braniff 9. Cathay Pacific 2. Eastern 40. Garuda 3. KLM 12. National 23. Pacific SW 3. Western 9. Non airlines 1.
Vickers *Vanguard*	40	BEA 20. TCA 20.
Vickers *Viscount* 700 Series	269	Aer Lingus 4. Air France 12. Alitalia 10. BAT 2. BEA 27. UBA 3. BWIA 8. Capital 60. Central African 5. Cubana 3. Hong Kong 2. Hunting-Clan 5. IAC 10. Iraqi 4. LANICA 2. LAV 3. MEA 7. Misrair 5. Olsen 6. PAL 2. PLUNA 3. TAA 14. TCA 51. THY (Turkey) 5. Non airlines 16.
Vickers *Viscount* 800 Series	114	Aer Lingus 3. Ansett-ANA 4. BEA 42. Continental 15. Cubana 4. Eagle 2. KLM 9. Lufthansa 9. NZNA 3. PIA 3. SAA 7. TA. 3. Transair 3. VASP 5. Non airlines 2.

Medium and Long-Range Turboprop Aircraft

Type	Bristol *Britannia 300*	Bristol *Britannia 310*	Vickers *Vanguard*	Ilyushin Il-18 *Moskva*	Tupolev Tu-114 *Rossiya*	Lockheed *Electra*
Country of Origin	GREAT BRITAIN			SOVIET UNION		U.S.A.
Engines (number and type)	4 × Bristol *Proteus 755*	4 × Bristol *Proteus 755*	4 × R.-R. *Tyne RTy.1*	4 × Kusnetzov Nk-4	4 × Kusnetzov Nk-12N	4 × Allison 501-D13
Max. sea level static thrust	4 × 4,120 ehp	4 × 4,120 ehp	4 × 4,795 ehp	4 × 4,000 ehp	4 × 12,000 ehp	4 × 3,750 ehp
Span	142 ft. 3 in.	142 ft. 3 in.	118 ft.	122 ft. 8 in.	~170 ft.	99 ft.
Overall length	124 ft. 3 in.	124 ft. 3 in.	122 ft. 10 in.	118 ft. 1 in.	~145 ft.	104 ft. 6 in.
Wing area	2,075 sq.ft.	2,075 sq.ft.	1,529 sq.ft.	1,318 sq.ft.	~2,700 sq.ft.	1,300 sq.ft.
Max. gross weight	160,000 lb.	175,000 lb.	141,000 lb.	127,900 lb.	~310,000 lb.	113,000 lb.
Max. take-off wing loading	77 lb./sq.ft.	84.5 lb./sq.ft.	92.5 lb./sq.ft.	97 lb./sq.ft.	~114.5 lb./sq.ft.	87 lb./sq.ft.
Max. payload (space limited)	30,000 lb.	28,000 lb.	25,000 lb.	30,865 lb.	~ 55,000 lb.	21,640 lb.
Max. fuel capacity	6,670 Imp. gals.	8,485 Imp. gals.	5,100 Imp. gals.	—	~16,500 Imp. gals.	5,360 U.S. gals.
Max. landing weight	130,000 lb.	133,000 lb.	114,000 lb.	—	—	95,650 lb.
Passenger capacity (tourist class)	133	133	96/128	100	170/220	81/85
Passenger capacity (first class)	—	73/93	76	75	120	44
Total freight volume	829 cu.ft.	829 cu.ft.	1,360 cu.ft.	1,480 cu.ft.	—	511 cu.ft.
Max. cruising speed	338 kn	—	370 kn	350 kn	400+ kn	388 kn
Recommended cruising speed (at average cruising altitude when marked *)	300 kn	300 kn*)	—	—	—	354 kn*)
Average cruising altitude	—	31,000 ft.	25,000 ft.	26,250 ft.	—	22,000 ft.
C.A.R. take-off field length for max. gross weight at sea level (I.C.A.N.)	5,200 ft.	6,200 ft.	6,500 ft.	2,460 ft. take-off run	—	5,800 ft.
C.A.R. landing field length for max. landing weight at sea level (I.C.A.N.)	3,350 ft.	3,410 ft.	—	1,970 ft. landing run	—	5,400 ft.
Typical still-air range (with payload given)	2,620 nm (30,000 lb.) 3,350 nm (19,000 lb.)	4,100 nm (28,000 lb.)	2,260 nm (25,000 lb.)	1,080 nm (30,865 lb.) 2,700 nm (17,640 lb.)	4,000 nm (38,500 lb.)	2,080 nm (21,640 lb.) 2,380 nm (17,500 lb.)

Short and Medium-Range Turboprop Aircraft

Type	Armstrong Whitworth AW.650	Aviation Traders *Accountant Mk.1*[1])	Handley Page *Dart Herald*	Vickers *Viscount 810*[2])	Fokker *Friendship*[3])	Antonov An-10 *Ukraina*	Convair 340 with Napier *Eland*
Country of Origin	GREAT BRITAIN				HOLLAND	SOVIET UNION	U.S.A.
Engines (number and type)	4 × R.-R. *Dart RDa.7/2*	2 × R.-R. *Dart RDa.6*	2 × R.-R. *Dart RDa.7*	4 × R.-R. *Dart RDa.7/1*	2 × R.-R. *Dart RDa.6*	4 × Kusnetzov NK-4 or Ivchenko	2 × Napier *Eland NEI.6*
Max. sea level static thrust	4 × 2,100 ehp	2 × 1,730 ehp	2 × 2,100 ehp	4 × 1,990 ehp	2 × 1,740 ehp	4 × 4,000 ehp	2 × 3,500 ehp
Span	115 ft.	82 ft. 6 in.	94 ft. 9 in.	93 ft. 8 in.	95 ft. 2 in.	141 ft.	105 ft. 4 in.
Overall length	86 ft. 9 in.	62 ft. 1 in.	71 ft. 11 in.	85 ft. 7 in.	75 ft. 9 in.	119 ft.	79 ft. 2 in.
Wing area	1,450 sq.ft.	632 sq.ft.	886 sq.ft.	963 sq.ft.	754 sq.ft.	—	920 sq.ft.
Max. gross weight	82,000 lb.	28,500 lb.	37,000 lb.	67,500 lb.	35,700 lb.	112,430 lb.	53,200 lb.
Max. take-off wing loading	56.6 lb./sq.ft.	45 lb./sq.ft.	41.8 lb./sq.ft.	70 lb./sq.ft.	47.4 lb./sq.ft.	—	57.9 lb./sq.ft.
Max. payload (space limited)	28,000 lb.	10,000 lb.	10,160 lb.	12,880 lb.	10,200 lb.	28,660 lb.	12,900 lb.
Max. fuel capacity	3,300 Imp. gals.	1,280 Imp. gals.	1,000 Imp. gals.	1,900 Imp. gals.	814 Imp. gals.	—	—
Max. landing weight	73,000 lb.	27,100 lb.	37,000 lb.	60,000 lb.	34,000 lb.	—	50,670 lb.
Passenger capacity (tourist class)	71/82	28	36	52	36/40	84/126	44
Passenger capacity (first class)	—	—	—	—	32	—	—
Total freight volume	gross 3,680 cu.ft.	—	—	370 cu.ft.	353 cu.ft.	—	—
Max. cruising speed	—	—	—	—	243 kn	390 kn	—
Recommended cruising speed (at average cruising altitude when marked *)	240—257 kn	253 kn*)	240 kn*)	316 kn	239 kn*)	300—345 kn	238 kn*)
Average cruising altitude	—	15,000 ft.	17,400 ft.	20,000 ft.	20,000 ft.	26,250 ft.	15,000 ft.
C.A.R. take-off field length for max. gross weight at sea level (I.C.A.N.)	4,050 ft.	3,220 ft.	3,700 ft.	5,350 ft.	4,330 ft.	2,600 ft.	4,600 ft.
C.A.R. landing field length for max. landing weight at sea level (I.C.A.N.)	2,280 ft.	—	2,260 ft.	—	3,000 ft.	—	3,700 ft.
Typical still-air range (with payload given)	1,735 nm (17,500 lb.) 870 nm (26,500 lb.)	885 nm (7,000 lb.) 400 nm (9,200 lb.)	1,150 nm (6,200 lb.) 570 nm (10,160 lb.)	835 nm (12,510 lb.)	700 nm (7,100 lb.) 175 nm (10,200 lb.)	1,100 nm (28,700 lb.)	840 nm (12,900 lb.)

Remarks:

[1]) *Accountant Mk. II* version with fuselage length increased to 72 ft. 1 in. for up to 40 passengers.

[2]) *Viscount 840* with four *Dart RDa. 11;* cruising speed 345 kn.

[3]) Version is offered with two R.-R. *Dart RDa. 7*, each of 1,960 ehp.

The control tower at Rhein-Main airport.

An Intercontinental Airport Expands

Frankfurt's Rhein-Main prepares for the jet age

In the list of major European airports, Frankfurt, Germany's leading airport, stands in a class with London, Paris and Rome. It was therefore no accident that the West German Government should have decided last year to treat this air transport centre as the Federal Republic's first jet airport and to encourage its expansion. Conditions at Frankfurt are unusually favourable as regards adapting the existing facilities to future air transport requirements, and the new building needed can be done at relatively low cost.

As long ago as 1933-34 it was realized that the old airport at Frankfurt (Rebstock) could not cope with the expected traffic development. Expansion was not possible, and as Frankfurt was also to be the starting point for airship services it was decided that the city needed a combined aircraft and airship base. For this purpose a stretch of woodland roughly 250 acres in area was selected to the south of the city, only 6 miles from the centre and at the intersection of the projected Kassel/Mannheim and Rhineland-Würzburg motor roads. The conventional airport was built on the northern portion, and the airship base, with two large airship sheds, on the southern portion.

The choice of this site proved to be extremely fortunate, not only from the traffic, but also from the topographical and meteorological points of view. The airship base was taken into service in May 1936, and the airport in July of the same year. Frankfurt became the terminal for scheduled airship services to North and South America (operated by the "Graf Zeppelin" and the "Hindenburg") and at the same time the European base for the airmail services which the Deutsche Lufthansa was operating (with conventional aircraft) between Germany and South America. As the airport also soon became a transit centre for the already highly developed European airmail and air freight network, and the connections offered here attracted international air services, Frankfurt moved up to second place among German commercial airports, behind Berlin-Tempelhof.

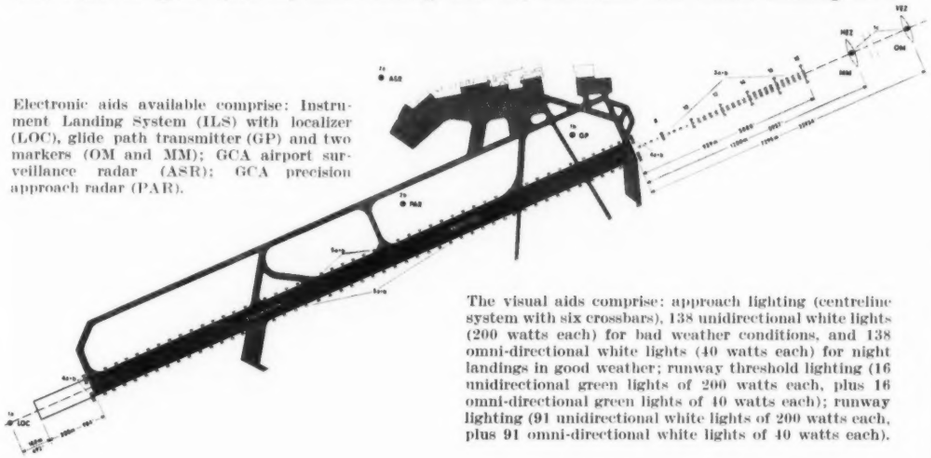
The war interrupted this development trend: Rhein-Main was taken over by the Luftwaffe, and the airship sheds were blown up in 1940. The airport buildings either fell victim to the air raids or were destroyed in the ground fighting round Frankfurt. The airport was then used by the Americans, who constructed a first runway 5,900 ft. long and 1,000 ft. wide and temporarily repaired some of the buildings.

The road from the ruins of 1945 to Germany's biggest airport, which recorded 52,485 aircraft movements, 1,153,018 passengers, 16,390,418 kg of freight and 6,575,258 kg of mail last year, was a long and hard one. Today the flags of 31 airlines from all continents fly from the masts at Rhein-Main, and Flughafen Frankfurt/Main AG, which operates the airport, has been able to manage without public subsidies since the 1956-57 business year.

Since Frankfurt airport was returned step by step to the German authorities, the latter have worked purposefully to perfect its installations. And it is to these efforts that Rhein-Main owes its reputation. The steeply climbing curve of its traffic performance and the airport's popularity with the airlines of all continents prove that the planners were working on the right lines when,

The 10,000-ft. (plus 1,000 ft.) main runway with its electronic and visual landing aids

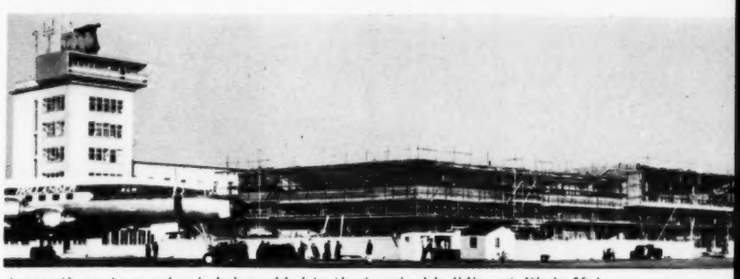
Electronic aids available comprise: Instrument Landing System (ILS) with localizer (LOC), glide path transmitter (GP) and two markers (OM and MM); GCA airport surveillance radar (ASR); GCA precision approach radar (PAR).



The visual aids comprise: approach lighting (centreline system with six crossbars), 138 unidirectional white lights (200 watts each) for bad weather conditions, and 138 omni-directional white lights (40 watts each) for night landings in good weather; runway threshold lighting (16 unidirectional green lights of 200 watts each, plus 16 omni-directional green lights of 40 watts each); runway lighting (91 unidirectional white lights of 200 watts each, plus 91 omni-directional white lights of 40 watts each).

Aerial view of the terminal building, apron and eastern end of the main runway (North) at Rhein-Main.

The heads of Flughafen Frankfurt/Main Aktiengesellschaft, the airport managing company; left to right: Dr. Otto Krauss (Under-Secretary of State in the Hessen Finance Ministry), Rudolf Lange, Walter Luz.



A new three-storey wing is being added to the terminal building at Rhein-Main.

despite restricted resources, they based their projects on the future growth of traffic and technical progress.

The expansion plans called in particular for the *lengthening of the main runway (north) to 10,000 ft., with an overshoot of another 1,000 ft.* When the lengthened runway and its new approach lighting were taken into service on October 28th, 1957, making Frankfurt one of the first airports in Europe to fall into I.C.A.O.'s *Class A*, the event was welcomed as a first step towards adaptation to the requirements of jet traffic. The runway can now be used by the biggest piston-engine aircraft taking off at maximum load. Incidentally, the first aircraft to take off from the lengthened runway was inaugurating scheduled non-stop flights from Frankfurt to New York.

If it should prove that the present runway length (10,000 plus 1,000 ft.) is not sufficient for intercontinental operations by Boeing 707s or Douglas DC-8s, a further extension of 1,300 or 2,000 ft. can be made within a few months. It is also possible to construct a third runway, if this is necessitated by increasing frequency of services. This runway would cover practically uninhabited terrain. Even with a considerable increase in traffic, however, the existing runway system should meet all requirements for the next few years.

In extending the main North runway, two high-speed taxiways, such as are recommended by I.C.A.O. and I.A.T.A. to enable better use to be made of existing runway systems, were constructed —the first in Europe. These taxiways enable aircraft to move off the runway at high speed after touchdown. The approaches to the runway were also lengthened.

The apron has been increased in area by 538,000 sq. ft. to permit the installation of *29 aircraft stands*, four of which are to be reserved exclusively for jet aircraft. All stands have power outlets and telephone connections, and are illuminated by a floodlight system. The stands on the southern edge of the apron, including those for jet aircraft, have fuel hydrants, their own parking area for ground service vehicles and a power supply station with transformer.

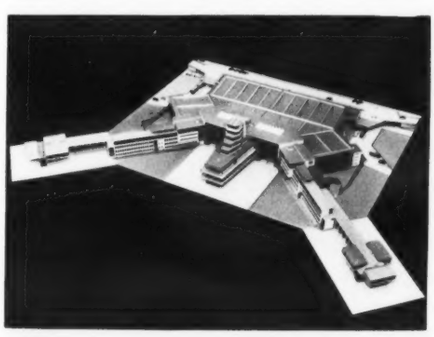
Finally, the terminal building is also being substantially enlarged by a new wing 105 ft. wide and 260 ft. long running out towards the apron. The ground floor of the wing will contain a 9,700 sq. ft. international waiting room, the call rooms, and offices for Customs and immigration services and the airlines. On the floor above will be more offices, and the top floor will house the more than 8,000 sq. ft. domestic waiting room and relevant call rooms. The latter will be connected to the apron by two separate stairways. The top floor will be connected to the old office block via foot bridges, and two stairways and escalators will provide access to all three levels in the new building.

The roughly 920,000 cu. ft. new building will provide a total of 59,500 sq. ft. of floor space and make it possible to install passenger handling and waiting rooms which will not only greatly speed up the flow of traffic but also make conditions for passengers at the airport as pleasant as possible.

The present extension, which has already been roofed over, is only an interim solution, however, and is designed merely to bridge the gap until a completely *new terminal building* can be planned and erected. The Frankfurt authorities have wisely decided to wait and see what developments follow on the introduction of jet transports in 1959 before investing large sums of money in a new main terminal building. As the latter would probably cost something like 30,000,000 Marks, the investment of 3,800,000 Marks in extensions to the old building would seem to be well worth while.

The airport management company can be well pleased. What it has already done has not only found expression in rising traffic figures and annually improving incomes . . . but Rhein-Main has become a well-known name on all continents.

Model of a projected new terminal building for Frankfurt airport (architects Giefer-Mäckler & Kosina) seen from the road side (above) and from the apron.



The extension to the main runway was completed at the end of October 1957.

The booking hall.

Lively activity in the open-air café... and on the apron

Rhein-Main's landmark.

The Air Navigation Angle

By Léon Boussard, Chief, Public Information, I.C.A.O.

Although the standards and recommended practices prepared by the International Civil Aviation Organization are designed for universal application, it has been and probably always will be necessary to make allowances for local peculiarities in different parts of the world. This is why I.C.A.O. has divided the world and the airspace into eight air navigation regions which overlap in part but which correspond to geographical, topographical or even political entities. The laws of the skies and of the air are and will remain dependent on the laws of the earth and the ground, although aircraft fly at ever increasing altitudes and ever increasing speeds.

Hence the extreme importance of the Europe-Mediterranean region, where national territories still form a confused mosaic despite efforts to put an end to the fragmentation of the continent caused by history, politics and the use of differing languages.

As in many other European fields, air transportation has raised such special local problems that it has been found necessary to set up a European Civil Aviation Conference. This conference is associated with both the Council of Europe and I.C.A.O. and is today headed by Colonel Luis de Azcárraga, Director of Air Traffic Control in Spain.

But Europe is not an isolated continent, remote from the rest of the world. On the contrary, its past, its economic activities and its cultures make of it a centre of attraction and a region to which nearly all countries of the world turn to exchange men, goods and ideas. What the Old World, as it is known, is doing today in the field of air transport falls within a general economic and political effort aimed at piecing together the old scattered jigsaw into a coherent picture.

This situation, added to the fact that we are today on the threshold of the jet age, explains the interest aroused by I.C.A.O.'s fourth Regional Air Navigation meeting in Geneva, the object of which was to seek international agreement or compromise on subjects such as meteorology, communications, air traffic control, search and rescue, airports and navigation installations and aids.

In this planning the military aviation requirements cannot be ignored. Without good coordination of the military and civil organizations, flying safety would be jeopardized. It is essential that the countries concerned should get together and reach agreement on this subject. The vast increase in speeds, the reduced visibility at high altitude, the great increase in fuel consumption and the planned reduction in the time allowed for certain manoeuvres such as stacking above airports, the greatly reduced time available to the controllers, the difficulty of applying vertical separation methods to turbine-powered aircraft which use a cruise climb technique or a climb in successive stages instead of the conventional methods of level cruise—all these necessitate effective control of air traffic at all times, with the abandonment of V.F.R. flying and coordination of military and civil aircraft movements. The pilot must receive constant and accurate information. Automatic devices will have to be increasingly utilized for the rapid and reliable transmission of position reports from aircraft and of instructions from the ground. A new system of navigation must be employed to enable aircraft to keep accurately to relatively narrowly-separated tracks when traffic density is high. Alterations to flight plans must be reduced to the strict minimum and should be made to the route rather than to altitude, in view of the handicap imposed on jet aircraft by increased fuel consumption entailed in a change in altitude. Again because of the consumption factor, and in order to avoid delays, modernized or new procedures for obtaining clearance to manoeuvre on the ground and to take off must be introduced. Alternative taxiways must be provided to enable jet aircraft to by-pass piston-engine aircraft warming up on the runway.

Accurate and suitably located navigation aids must be established, and restrictions placed on climb in regions of dense traffic, to permit uninterrupted climb to cruising altitude. Pilots must be notified in good time of any likely delays in landing, since jet aircraft flying at high altitude and high speed must begin their descent a long way from their airport of destination.

The establishment of flight information regions and centres for the upper air, quite distinct from the many regions and centres hitherto formed for lower altitudes, has now been recognized as essential.

*

It was clear as early as 1952 that much needed to be done to improve the transmission of meteorological information between airports and between the ground and aircraft in flight. Because attempts were made to continue old traditions and old habits, there was a lack of organization and a wastage of equipment and time, as well as a bad distribution of frequencies. Moreover, the whole organization was already recognized as out of date and inefficient (there were four systems of communication between airports and three for ground-to-air communications).

By 1956 I.C.A.O.'s Air Navigation Commission had arrived at the conclusion that the European system of meteorological communications should be reorganized, in view of the unnecessary expense, lack of efficiency, inadequacy or uneconomic employment of technical equipment and personnel.

It was therefore decided to hold a special conference under the auspices of both the World Meteorological Organization and I.C.A.O., to work out an adequate plan for meteorological communications to be incorporated in the general European communications system. I.C.A.O. was to be responsible for the operational side of the system, and W.M.O. for providing the synoptic data and preparing the charts.

As the coming jet aircraft will operate at higher altitudes than civil transports have done hitherto, meteorological assistance must be provided up to barometric altitudes of at least 46,000 ft.

Night flying activity over London Airport. The condensation trails tell their own story...

Flight Information Regions in the Europe-Mediterranean area. Map shows the Flight Information Regions (F.I.R.) existing today in I.C.A.O.'s Europe-Mediterranean region. Among the questions discussed at the 4th Regional Air Navigation conference, which met in Geneva at the end of January 1958, was the creation of Upper Air Information Regions (U.I.R.) superimposed on the Flight Information Regions. Object is to provide better weather information for jet aircraft cruising at altitudes of up to 46,000 ft.

The following forecasts are required for the preparation of a flight: forecast to within one degree centigrade of the ambient temperature above the runway in service at average altitude, to be available two hours before take-off; forecasts of the wind force during climb to initial cruising altitude; forecasts to within three degrees centigrade of the ambient temperature at selected barometric altitudes; for I.F.R. flights, landing forecasts for the airport of destination and for the first alternative airport, to be available before the aircraft reaches the critical point where the pilot must decide either to detour to the alternative airport or begin his descent; forecasts of the altitude of the tropopause along the route and in the neighbourhood of the route, the location and characteristics of jet streams, hail, turbulence in clear air, turbulence in the clouds, icing conditions and dense cirrostratus. In addition, the methods of measuring visibility along the runway and oblique visibility must be improved.

*

Traffic density is increasing. Speeds and operating altitudes are augmenting. The time spent flying at low altitudes must be reduced to the minimum. In the present state of affairs, the question of the speed of transmission, whether by fixed or mobile services, is undoubtedly more important than the question of traffic volume.

The whole system of navigation aids must be re-examined, for both short distance and medium distance navigation, and regional coverage must be provided, with graphical presentation in the pilot's cockpit.

Special radio aids will be necessary to enable aircraft to locate and accurately follow the stacking circuits. During climb and descent aircraft must be able to hold accurately to the prescribed track, and the precise position of aircraft on this track must be known.

It may also be necessary at the major airports to use special aids to speed up surface movements, so that turbine-powered aircraft can reach their take-off position without delay. Airport surface movement indicator radar can solve this difficulty.

The pilot's task in the field of communications must be reduced to the minimum. Hence the need to introduce automatic systems for the relay of information. Consideration is now being given to the use of radio facsimile transmission and the employment of low or high frequency teleprinters to provide crews with information in printed form in the aircraft.

*

When it comes to the question of airports, it is not sufficient to keep up-to-date lists of the main scheduled airports and alternatives. Here again, the forthcoming introduction of jet aircraft raises considerable problems. These aircraft have a very high gross weight. They need longer runways for take-off and landing at a weight in the neighbourhood of their gross weight. The temperature and speed of jet exhaust are higher than those of piston engines, and the noise level is also higher. It is not very likely that, under normal temperature conditions, the exhaust should damage good quality pavements, but it may be necessary to provide specially resistant surfaces for the run-up points at the end of the runways. Special attention must be given to the joints and sealing materials for concrete runways. Surfaces at refuelling points and hard standings must be specially treated to resist the effects of jet fuels. Recent experience has revealed the absolute necessity for keeping runways meticulously clean, since the smallest object can be sucked in by the jets and cause serious accidents.

The heavy consumption of fuel on the ground requires that taxiways be arranged in such a way as to reduce surface movements to a minimum and to enable aircraft to make ground turns at speeds of between 30 and 45 knots. Changes in airworthiness requirements, the use of noise-suppressors and of thrust reversers may modify the runway lengths at present envisaged. Increasing speeds make improvement to visual runway and approach aids more necessary than ever. Distance markers on the runway or devices to measure acceleration aboard the aircraft must be provided to enable the pilot to determine whether his take-off is progressing safely. The noise of turbine engines must be reduced to the level now accepted at airports and in their vicinity.

*

In Europe, as in most other parts of the world, it is probably less difficult to construct or modify international airports than to recruit and retain the qualified personnel required, and finance the installation and operation of the meteorological and communications equipment and services.

It is obvious that, if the difficulties are to be met and the deficiencies made good, so as not to delay the introduction of the new aircraft types into service, the solutions proposed by the experts must be carefully examined from the *economic* point of view. It is not sufficient to find and recommend the best technical solutions. There must also be the ability to finance the equipment, organization and operational plans.

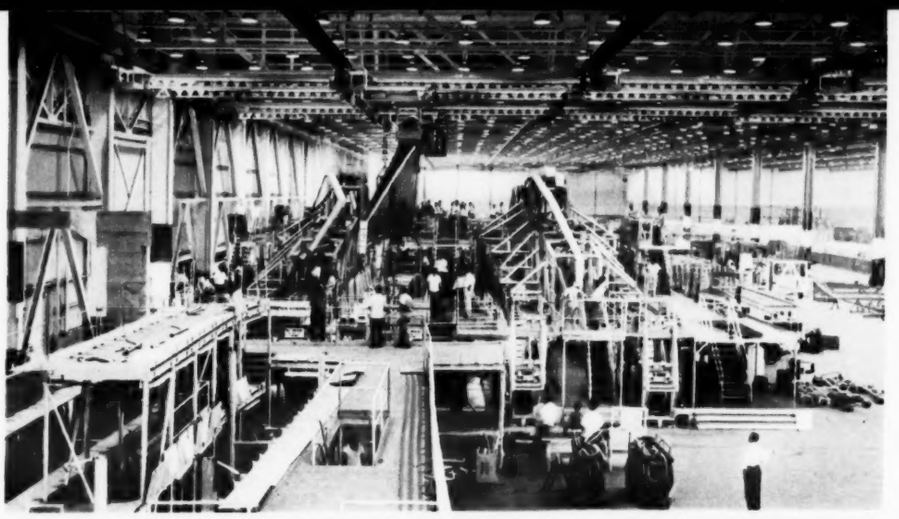
This is a difficult question and reveals clearly that the real international problems awaiting attention can be solved only by cooperation between governments, even on the regional level.

Opening session of I.C.A.O.'s 4th Regional Air Navigation conference on the Europe-Mediterranean region in Geneva's Palais des Nations. Left to right: the conference president P. G. Senn (Switzerland); H. Adam (I.C.A.O.), Conference Secretary; L. L. Bédin, director of the I.C.A.O. Regional Bureau in Paris.

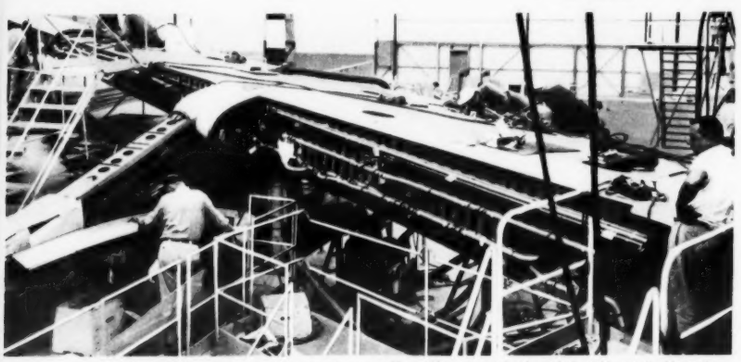
European Air Transport

The DC-8 in Production

Production of the DC-8 jet transport is advancing according to schedule in the new Douglas facility at Long Beach, near Los Angeles. Here roughly three-fifths of the floor space (overall dimensions 890 ft. × 1,144 ft.) are given over to stations for the manufacture of complete wing units (from the construction of spars and cutting of wing plates to sub-assembly and wing installation) and complete fuselages (consisting of nose sub-assembly, fuselage cylinder and rear fuselage). The other two-fifths house the final assembly line, with 12 stations. The pictures on this page show some of the more striking production stations.

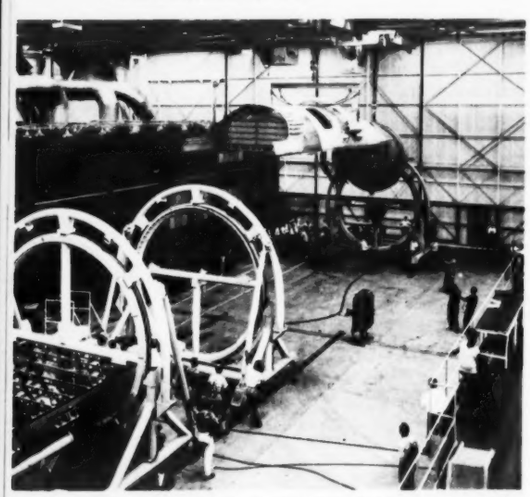


The wing tank assembly jigs (80 ft. in length) with three working levels, for matching, drilling and riveting of the skin sheets.



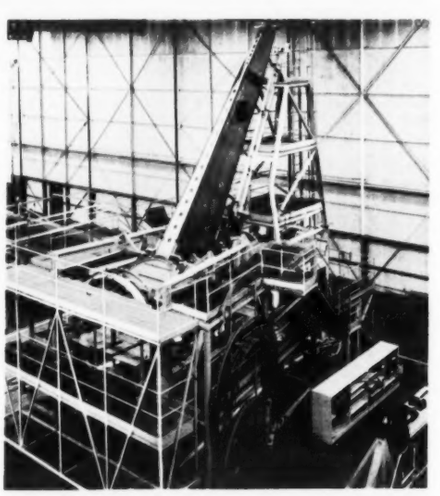
Attaching the pylons for the engine nacelles (plus electrical and fuel lines) to the wing, now in a horizontal position.

Nose assembly: in the rear are the jigs for the lower section (assembled in an upside-down position).



The lower fuselage sections (assembled upside down) are placed in turning rings which bring them into normal position for joining with the top halves.

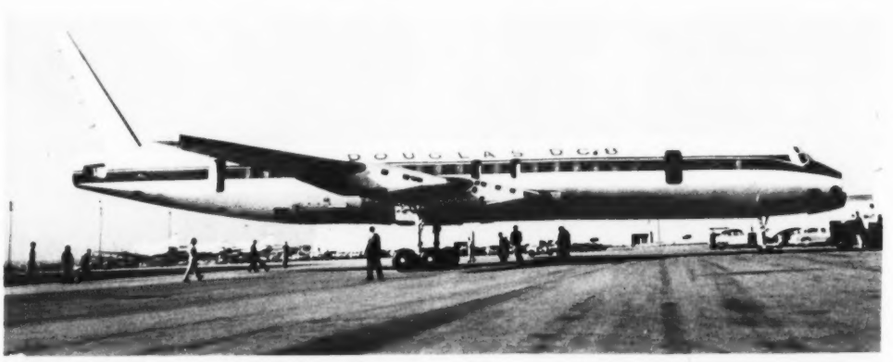
Fuselage joining; clamps hold the skin and frames together ready for riveting.



The 38-ft. jig for assembling the tail stub and vertical stabilizer. Work is possible on four levels.

One of the twelve stations on the final assembly line: the wing has already been attached and the nose gear installed.

The first production DC-8, before installation of the engines, tailplane and other components.



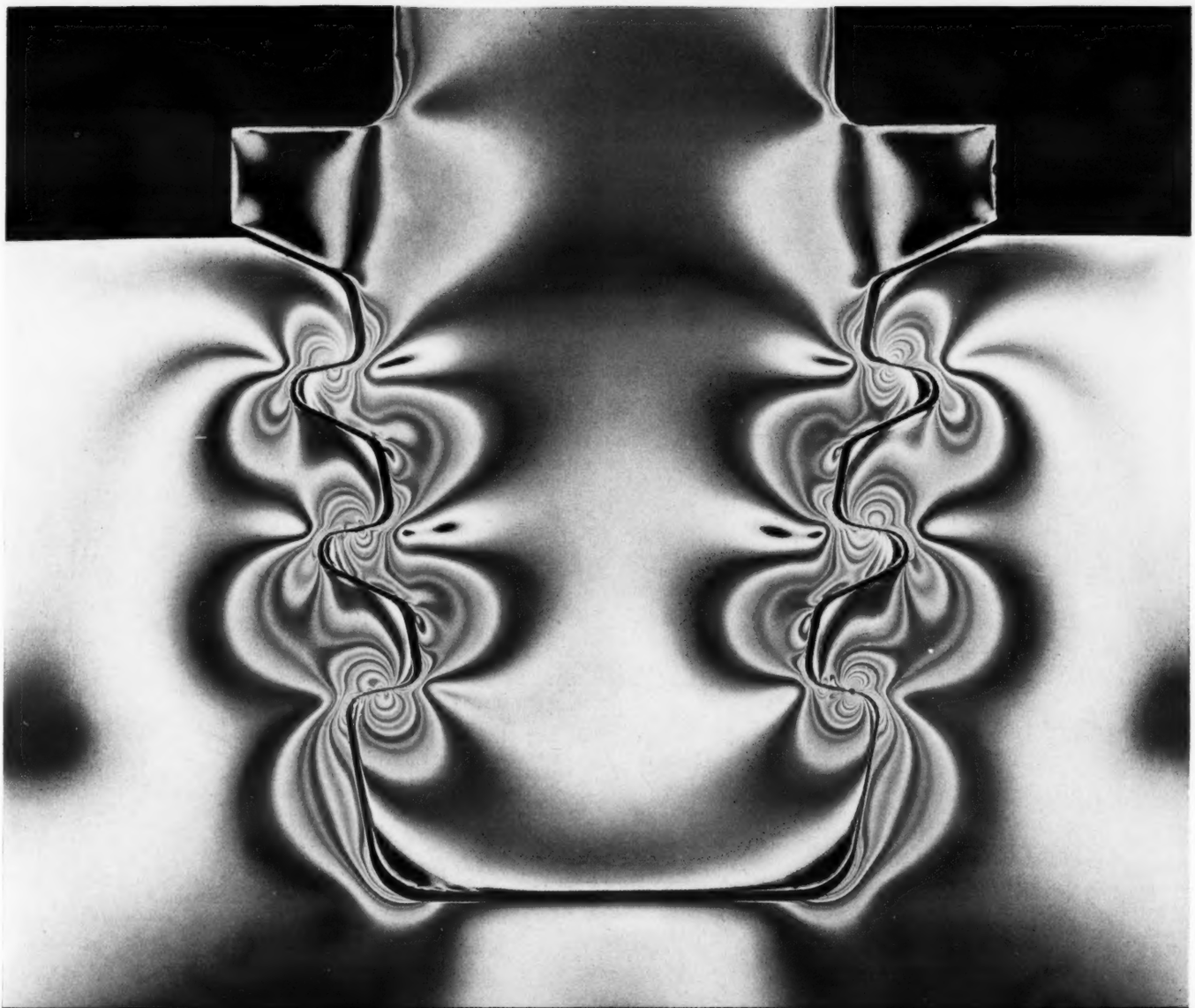


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Illustration shows stress patterns in a jet engine blade root under load, using color photography and photo-elastic stress analysis.

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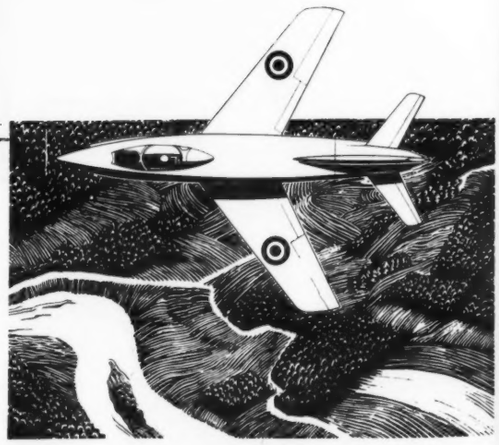

THE LIGHT STRIKE FIGHTER FOR NATO

Basic advantages of this aircraft: ability to operate on semi-prepared fields or grass runways, short take-off and landing distances, high manoeuvrability, small dimensions, low weight, low unit and operating costs.

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What is Automation?

In its present usage the word "automation"[1] is unfortunately ambiguous, since it denotes two different things: 1–technological methods which make an object or process "self-moving" or automatic; 2–the partial or complete automatic operation of an undertaking (factory, bank, commercial firm, etc.) or administrative organization (e. g., air traffic control).

The word is said to have been coined by D. S. Harper, Vice President of the Ford Motor Company, Detroit, back in 1947. It was immediately taken over into English-American technical terminology and has since invaded non-English literature, thanks to its classical roots.

Basically it would be more practical to restrict the use of the word "automation" to the economic-administrative side of an automatic production, distribution or control system. Technical descriptions should use more precise terms to define exactly what is meant: for example, an automatic machine tool or production line, automatic feedback control, etc.

An examination of the technological side of any automatics (or automization) reveals the following *stages:*

1–Replacement of human labour by machine work = *mechanization;*

2–Replacement of human control of the machines by mechanical or electro-mechanical control to a pre-determined programme = *automatically controlled mechanization (or partial automation);*

3–Replacement of human supervising activity by the feedback of the results of automatic inspection to the control programme, in the form of either intermittent or continuous intervention = *complete automatic control or full automation.*

Thus only stage three—automatic control with closed circuit feedback and continuous influencing of the programming by the inspection system—can be termed automation in the full sense of the word.

By why does man try to automatize something? The answer is that, whether the "something" is a non-material process (e. g., a computing or search process), an object (e. g., postage stamp machine) or a production process (e. g., bread baking), automation will be introduced only if it is necessary for technical reasons or is *expedient* for economic or social reasons.

Automation for technical reasons

Man is a sensitive creature with very limited physical and mental capacities: he can carry barely a hundredweight load; his top speed is 20 m. p. h.; his normal walking speed is at best a sixth of his top speed; he cannot withstand high or low temperatures, or high accelerations; he needs food and drink, a regular supply of oxygen to his lungs and a given air pressure on his body; he is sensitive to toxic substances and radiations and has only a limited perception capability and a limited memory. Finally for whatever he does, even with full concentration, he needs a certain time, varying from case to case, to make and initiate a decision, the so-called reaction time. All this is accompanied by a deep-rooted compulsion to investigate, master and convert nature, which constantly drives him on to new voyages of discovery and new conquests.

This examination of man's physiological and psychological limitations leads directly to the technical reasons for using automatics:

1–Automatic devices must first replace man in hazardous environments, such as high altitudes and at high accelerations (examples: research rockets and guided missiles), in the handling of toxic substances (examples: sulphuric acid production and atomic reactors), in the neighbourhood of high temperatures or other sources of danger (examples: blast furnaces, steel rolling mills, etc.).

2–Automatic devices replace or reduce drudgery, the lowest form of human activity, for example in mines and stone quarries, in the carriage of heavy loads, in agriculture and the building industry . . . and as a rule also prove to be cost-saving.

3–Automatic control devices substitute for man either to relieve the burden on him (example: automatic pilot) or because they work faster and more reliably (examples: the control centre in a power station and the automatic telephone exchange).

4–Automatic sensing organs, such as radar and infrared devices, replace the human senses, often with a thousand times the range and with unlimited attentiveness.

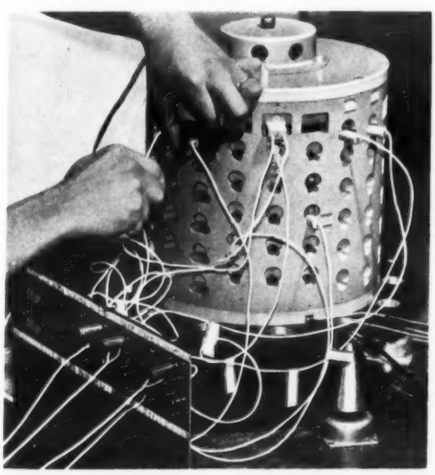
5–Automatic memories replace the average man's limited perception capability (plus all his filing systems). They range today from the pot-sized magnetic drum unit in a simple computer *(picture)* to the Bank of America's 25-ton Erma electronic book-keeping machine which can store 300,000 account numbers on 300 memory tracks.

6–Computers do the work of whole regiments of mathematicians (which could not be recruited today) in a small fraction of the time the latter would take. For example, the IBM 704 computer (43 tons, floor space roughly 3,000 sq. ft.) is capable of working out the logarithms of every number from 1 to 10,000 to ten digits in 10 seconds and of recording the results on magnetic tape in another 7 seconds. If it were also desired to print the results in tabular form on a paper tape, a modern American high-speed printer could accomplish this task in roughly two minutes. By comparison, the Scottish mathematician John Neper (1550—1617) took thirty years to work out the first logarithmic tables.

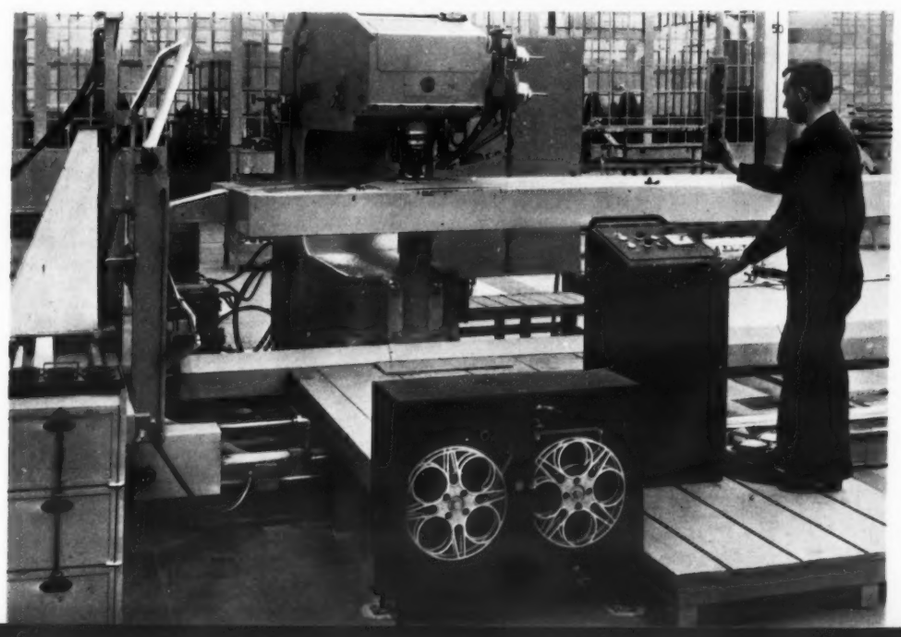
7–Automatic production installations are useful for *technical* reasons (economic reasons will be discussed later) where production must be completed under pressure of time and where very

[1] "Automation" is a hybrid word built up of the Greek root "automatos" (moving of itself) and the Latin suffix "ion".

Despite its small dimensions the magnetic drum memory unit of the Ramo-Wooldridge RW-300 computer can store nearly 8,000 words.



This fully automatic riveting machine in Fiat's aircraft division is controlled by a punched tape which runs over two spools like a movie film.



high precision requirements must be met, in particular for the manufacture of small or medium batches of military aircraft and guided missiles during an arms race. The American airframe industry operates a large number of programme-controlled milling machines, some of them working on the analogue principle (templates or models and reading head), others with numerical control (punched tape and magnetic tape control). The second process *(pictures)* is more accurate, is more easily adapted to structural modifications in the work piece and is therefore generally preferred today.

Automation for economic reasons

Partial or full automation will not be introduced into any undertaking—production plant, trading organization, bank, communications service, or administrative agency—for economic reasons unless the new organization promises to be cheaper than the old or unless it has become impossible to obtain the required number of suitably qualified workers. If, for example, it were decided to replace the fully mechanized bakeries of today's large cities by hand bakeries, it would very soon transpire that there were not enough skilled bakers to man them.

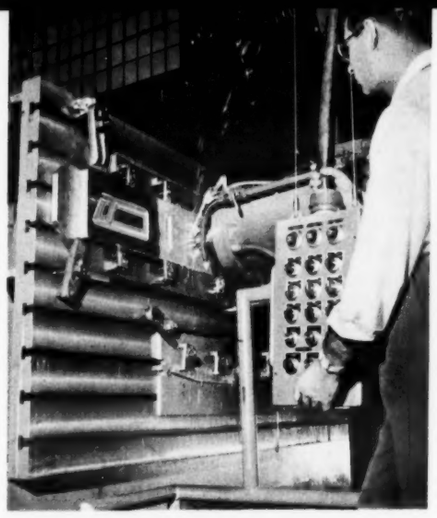
The showpieces of industrial automation are of course the cost-saving machine tools and integrated conveyor systems for mass production. What would an automobile, an aircraft engine, a ball bearing, a food can, cost if made chiefly by manual labour in small workshops? It is sufficient to recall that every four-engine airliner (and there are still something like 2,000 of them flying with piston engines) has some 72 cylinder heads and an equal number of cylinders, not to speak of the spares on the storeroom shelves. For parts manufactured in such large numbers it is worth using high-cost *transfer machines*, consisting of several suitably grouped special machine tools (one machine for each work process) and automatic conveyor and clamping devices. Transfer machines have long been in use in the aircraft engine industry, for example in the manufacture of Pratt & Whitney's R-2800 *Double Wasp*. But they are also being used to an increasing extent in the airframe industry, despite the smaller batches produced, for example for certain parts of the Convair F-102A all-weather fighter *(pictures)*.

It is not possible in the space available here to go into the economic and social repercussions of automation in industry or administration. It may, however, be mentioned that the number of industrial branches to which automation could be applied today is very large[2], but that the proportion of workers which will be affected by redeployment within the foreseeable future is estimated at not more than 10 percent of the present labour force. In the United States the labour unions, led by Walter Reuther (United Automobile Workers) have come out in favour of automation, provided certain demands are met (guaranteed annual wage, shorter working week). In the Soviet Union, where the Government represents the interests of the employees, a Ministry of Automation has been created. In Britain, France, Germany and other countries discussions are still in progress.

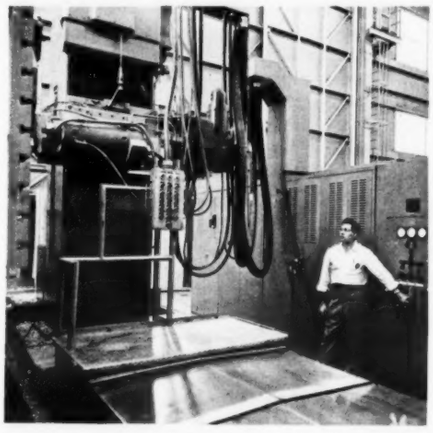
Automation and aviation

In view of the growing importance of automatic production and operating systems in aviation, *Interavia* has decided to publish a series of articles and reports on the subject, beginning with the present issue. A general article on "Rationalization", the prerequisite for automation, by Under-Secretary of State Professor L. Brandt, is followed by the description of a spectacular example of administrative automation, the S.A.T.C.O. automatic air traffic control system. This in turn is followed by brief articles on automatic seat reservation for the airlines and on fully automatic landing, plus a longer report on the partial automation of the spares provisioning system for Boeing's new jet transports. Other articles on programme-controlled machine tools and computers will be published in later issues.

[2] Excellent examples are given in the sections headed "Computers" and "Automatics" in the "Electronic Engineer's Reference Book" (Heywood & Company Ltd., London, 1958) and in the book "Automatisierung" issued by the Rationalisierungs-Kuratorium der Deutschen Wirtschaft (Carl Hanser Verlag, Munich, 1957), in both cases with comprehensive bibliography.

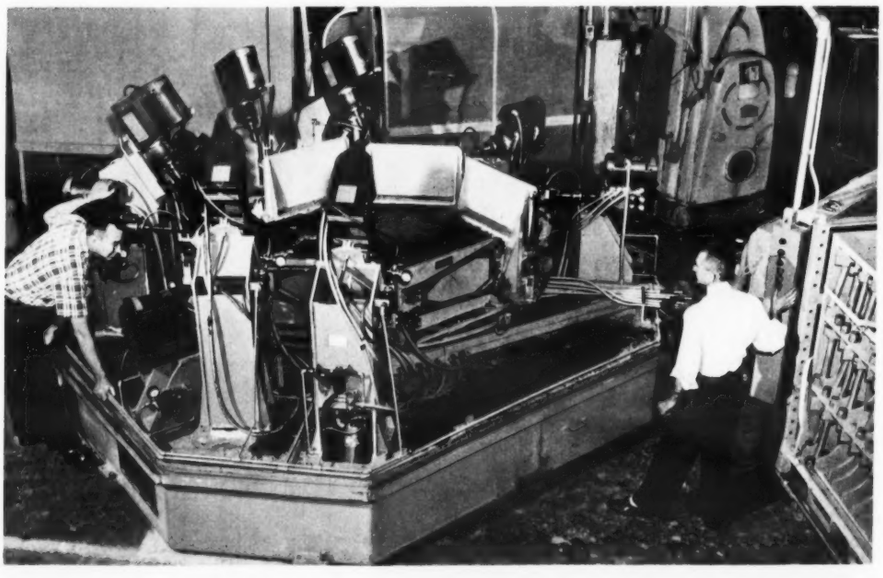


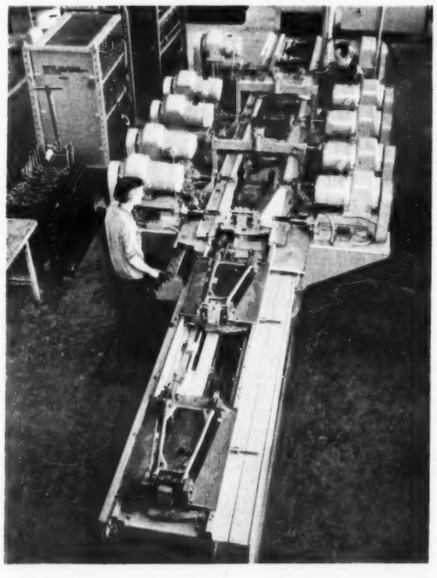
Three-axis cutting tool of the numerically-controlled (by means of a magnetic tape) Gidding & Lewis profiler at Convair's San Diego plant. The operator need only supervise the work process and exchange the tool as required.



General set-up of the profiler and its electronic control cabinets: the vertical bed (left) holds work pieces up to 48 inches wide and 168 inches long; the programme-controlled machine tool moves in three dimensions along the overlapping fixture (centre). The machine fabricates components for the Convair F-102A all-weather fighter.

The two pictures below show two semi-automatic transfer machines for drilling, reaming, etc. a weldment for the Convair F-102A. The machine on the left (eight stations) drills, taps and spot-faces grease fitting holes; the machine on the right (with three stations) drills, reams and taps the bearing points on the same weldments.





Rationalization

By Under-Secretary of State Professor Leo Brandt, Düsseldorf

Today's economic watchword is rationalization and research in all fields. Scientific research alone is not enough. Before development and production can be rationalized, the results of basic research must be translated into practical application through the medium of applied research. The rate at which this is done decides on its degree of success. Dr. A. King, deputy head of the European Productivity Agency, Paris, has calculated that it takes ten years to convert new scientific discoveries into practical results. Economically speaking this is too long, and the whole process should be speeded up. For example, manufacturing equipment should not be kept until it begins to wear out or its official depreciation life is completed, but should be replaced as soon as a more efficient, more rational device becomes available. Admittedly, other factors besides the desire for progress play an important part here, such as the general economic situation, the market situation and the financial situation of the company concerned. Nevertheless, the speed at which research results are transformed into practical use is of decisive importance in productivity and rationalization of any branch of the economy.

The Aachen Institute of Technology's *Rationalization Research Department*, the first of its kind in Europe, has developed, as one of its first basic research tasks, a method of assessing man-hours and costs, and has put it to practical test in the die-making industry. The companies involved in the first series of tests were initially hesitant about offering their full cooperation. But when the results emerged, all previous ideas of the advantages of rationalization in this industry group were found to be far too modest. In certain manufacturing processes there were cost differences of up to 400 percent. Taking the best individual results of all the plants concerned as the basis for an "optimum" plant, it was found that 60 percent of total man-hours and costs could be saved. What could be more obvious than that the companies participating in the experiment should get together to exchange ideas and experience, with a view to drawing practical advantage from rationalization techniques? Another experiment of the same nature carried out in the gear wheel industry—where capital investment is high, as compared with the die-making industry where labour costs are high—brought similar results.

Among the special problems involved in rationalization which require research and organizational work of a particular kind, is the *standardization of dimensions and design*. A modern economy is unthinkable without standardization of dimensions. Screws, nuts, threads, rivets, bores should be standardized, if possible on an international basis, since such standardization is an essential for rational mass or quantity production, for licence production and repairs. Standardization of designs means reducing the number of types of equipment or other items larger than nuts and bolts. One curious outcome of the present lack of standardization is that West Germany, for example, has produced 3,000 types of watch and clock and 6,000 types of shovel since the war.

In *industrial rationalization*, automation means a particularly well organized production flow, in which machine tools, transfer machines, control, feedback and inspection equipment are combined into a coherent whole to ensure rational manufacture in the smallest possible space, with good utilization of materials and with a minimum of human labour. As in any step towards rationalization, the introduction of automation must be preceded by detailed costing and market analysis. Equally important is advance planning for the redeployment of the labour force, to avoid labour disputes. Transfers of workers to other firms must be planned in good time in conjunction with the labour exchanges. As in the United States,* the cooperation of the unions will be secured if, in planning transfers, full consideration is given to seniority rights, wages and holiday conditions.

Basically automatic production entails a *labour shift* from actual production to production preparation. This preparation includes the planning, development and manufacture of production equipment for new factories, which will to a large extent have to be tailored by skilled workers and engineers to meet individual requirements. The age of automation will demand much better vocational training than has been usual hitherto, as there will be an increased need for first-class skilled workers and technicians with good all-round education.

Routine work, in organization and administration as well as in production, will be taken over to an increasing extent by computers, which are more efficient than human labour in tasks such as preparing continuous operating statistics and handling payrolls, stock inventories, orders and demand notes. Highly complicated scientific tasks can also be solved with the aid of electronic computers. In the United States, for example, the matrix system is used for long-term economic forecasts, which greatly facilitate investment and other planning.

Another important requirement for rationalization is a *documentation service* to collect, evaluate and classify scientific literature and provide rapid information on any individual subject. Scientific literature has taken on tremendous proportions during recent years. No research task can be undertaken rationally until existing work on the basic problems directly and indirectly involved has been studied. Otherwise there is a danger of overlapping and duplication of effort, or in other words "unproductive" research. Moreover research work is by no means confined to the discovery of new principles, but is even more widely concerned with coordinating results already obtained.

The development of aviation offers many examples of such coordination research, the latest being the recent launching of artificial satellites. A significant point in the latter connection is that the Russian documentation centre which handles Western literature employs 700 scientists and 14,000 assistants. At present 15 percent of the total scientific literature is of Russian origin, and by 1960 the Russian share is expected to grow to 40 percent. Hence within a few years the West will have difficulty in evaluating this material for want of sufficient translators.

Rationalization has always been a feature of the aircraft industry, which has had to utilize the most advanced design and manufacturing methods of the day. High precision manufacture is essential in order to meet flight safety and weight-saving standards, and the multiplicity of parts necessitates division of labour and a high degree of specialization. The same applies to the assembly of aircraft. During the past few years integral structures have been introduced for major assemblies in airframe manufacture, opening up new scope for rationalization in design and manufacture which also benefits other production branches. Basically, the exchange of materials, methods and production processes between different branches of industry is an important form of rationalization. A good example of this is the influence of the aircraft industry on new construction methods in the machine tool industry for large presses and milling machines.

In other directions, too, the aircraft industry has led the way to advances in other industries. Without aviation, light metals would never have attained their present significance, and there would have been no light metal industry. All internal combustion engines, including those used in locomotives, ships and motor vehicles, have benefited decisively from the development of aircraft engines and gas turbines. Whole industries producing instruments and accessories owe their existence to the requirements of aviation.

The repercussions of aviation on the natural and technical sciences are equally significant. In aircraft and engine production, materials must be used to the limits of their efficiency, whereas up until the last war bridge-building, for example, could afford to over-dimension and avoid any accurate study of forces and stresses. Today accurate load calculations and relatively low safety factors have also been introduced in bridge and steel-frame building, which has led to tremendous saving of materials. The new bridges built across the Rhine after the war weigh only half as much as their predecessors.

In *air transport* the high investment cost of a jet aircraft necessitates a high degree of utilization and a long life. Standardization, exchangeability, simplified spares inventories and other rationalization measures here again reduce costs and improve safety. Whether it is rational that the large jet aircraft should necessitate the construction of giant runways at every major airport is another question. And what a rewarding task it would be for rationalization engineers to tackle the transhipping problem in our transport industries!

Air transport has long progressed beyond its infancy. Today, the need is to watch dollars and cents and to survive without subsidies in the world of free competition. Credit is therefore due to *Interavia* for opening its columns not only to the more spectacular events of obvious progress, but also to sober consideration of rationalization, improvements in economy and increases in productivity.

* "Automation and the Technological Change", United States Government Printing Office, Washington, 1955, p. 97 etc.

Automatic Air Traffic Control

The S.A.T.C.O. System

The build-up in density of air traffic at the approaches to the major airports is today reaching such a peak that there is a very real threat of swamping the contemporary "manual" control systems. It is with the object of easing this situation that the Dutch firm N. V. Hollandse Signaalapparaten of Hengelo have studied and developed their S.A.T.C.O. System (Signaal Automatic Air Traffic Control System); operating fully automatically this system offers not only a more rapid handling of traffic at control centres, but permits a degree of operational efficiency which is not likely to be achieved by human operators alone.

In other words, automatic traffic control offers a high degree of flight safety and provides for the optimum increase in handling capacity, both in the terminal areas and *en route*, with a corresponding reduction of the delays which are now arising from the increased volume of traffic.

Based on exhaustive discussions with the airline companies and traffic control authorities, the company was able to arrive at the following basic requirements to be covered by a new, automatic control system. These factors led to the design and development of the S.A.T.C.O. System:

- Any new equipment must fit into the present pattern and should not pose problems of major changes in either flying procedure or the present basic organization of air traffic.
- The system should continue to make use of existing radio and navigational aids without requiring special equipment in either aircraft or at neighbouring control centres, as it would be extremely difficult to achieve the standardized equipment of *all* aircraft and control centres with special instruments.
- In emergency, controllers should always be able to override the automatic processes.
- All categories of aircraft should be covered.
- Capable of adaptation to the particular requirements of any control centre or airport.
- To be incorporated into existing systems by degrees until a fully automatic, integrated air traffic control system is completed.
- Offering the possibility of continued manual operation in the event of a power failure.

The complete S.A.T.C.O. installation comprises three main components:

- Automatic data processing equipment.
- Automatic radar equipment.
- Automatic communications equipment utilizing normal teleprinter networks.

The data processing equipment may be used independently of the other components, or normal radar and communications can be used in place of the automatic; in the latter case the system will not be fully automatic.

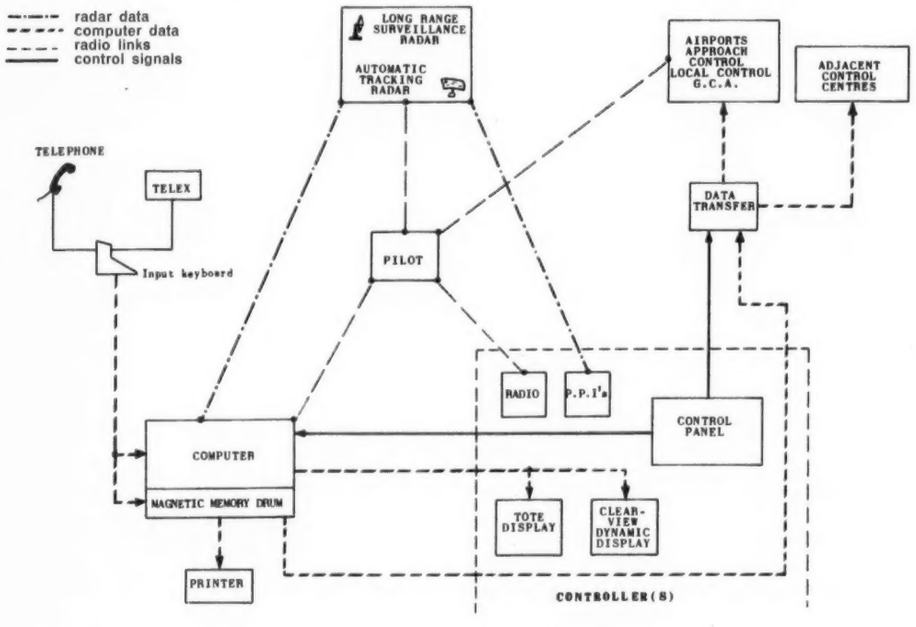
Flight plans and departure messages, as well as transfer messages received by teleprinter from neighbouring control centres, are fed into the S.A.T.C.O. system, where the teleprinter signals are encoded at the input of the computer. The computer then assesses the flight path, calculating the expected times of arrival at reporting positions along the route, checking this information against the flight paths of other aircraft already in the system, and calculates a safe flight path. The results are recorded on a magnetic memory drum, and are presented to the controller both on a "tote" type of display and on a dynamic "clear-view" display which shows the position of the aircraft in three dimensions. At the same time data are automatically printed on a progress strip.

The progress of the aircraft through the system is subsequently checked either from position reports or by radar. If position reports from the aircraft necessitate corrections, these must be fed into the system by the controller manually, and will then be calculated, and if necessary the clearances will be corrected. In the case of radar corrections the data are fed automatically into the system which will again correct the clearances and warn the controller of any changes which may have to be made. The automatic functioning of the radar system is achieved by the use of special long-range tracking radars linked with long-range surveillance radar.

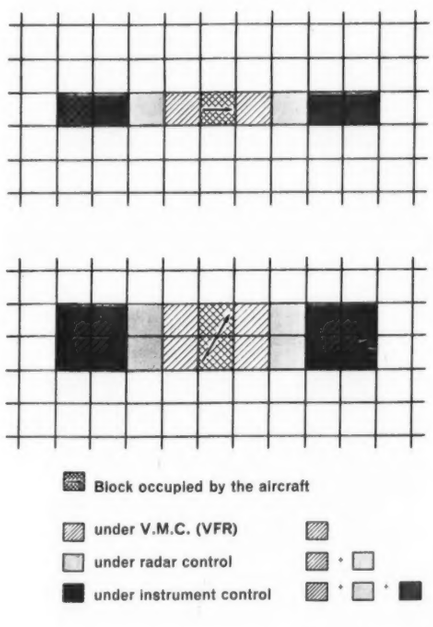
Transfer of control of the aircraft either to the approach control or an adjacent control centre is carried out by a simple push-button process on the tote display panel. This process interrogates the memory of the system and automatically dispatches the extracted information in telex code so that, even if the adjacent centre or airport is not equipped with S.A.T.C.O., the data may still be received on a normal teleprinter.

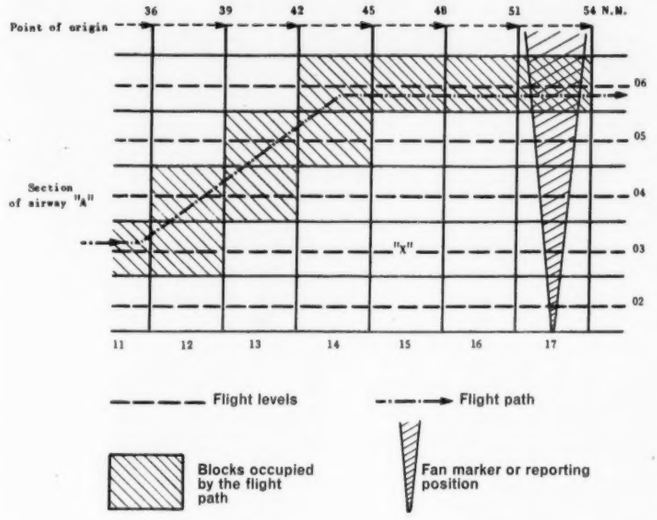
Every aircraft will be continuously controlled until it has either landed or has been taken over

Block diagram of the S.A.T.C.O. System



Flight separation: level flight (above) and climbing or descending flight (below)



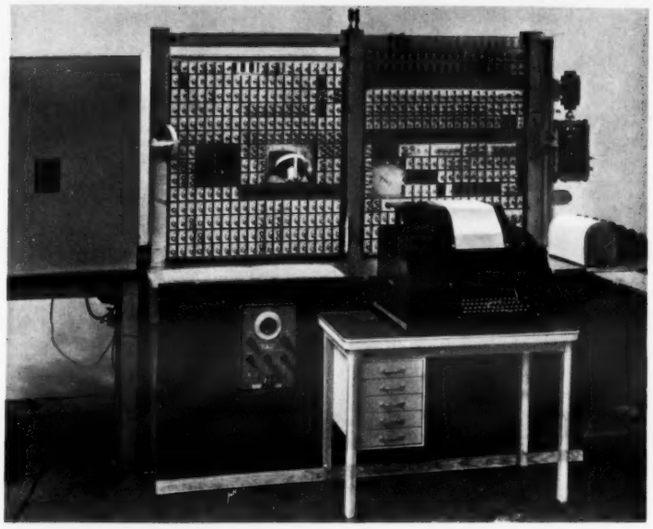


The S.A.T.C.O. block system

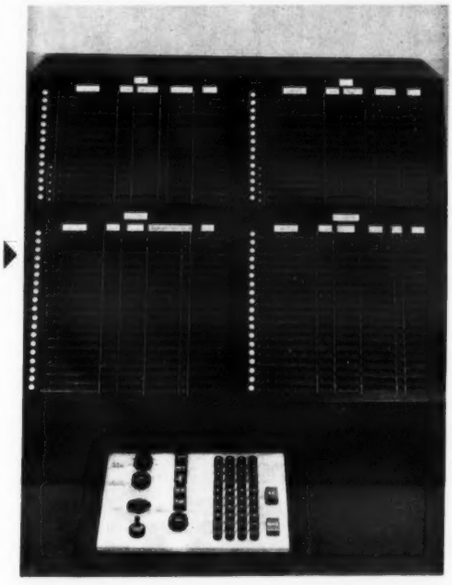
Dimensions of each block: length 3 nm; vertical 1,000 ft.; width that of the airway or the flight path.

Block numbering is based on a) the airway; b) one-third of the distance from the point of origin, and c) the altitude. For example Block "X" is A.1503.

Block occupation time is calculated on the basis of times of crossing the vertical lines. In the flight path illustrated Blocks A.1203 and A.1204 would be "occupied" at the same time.

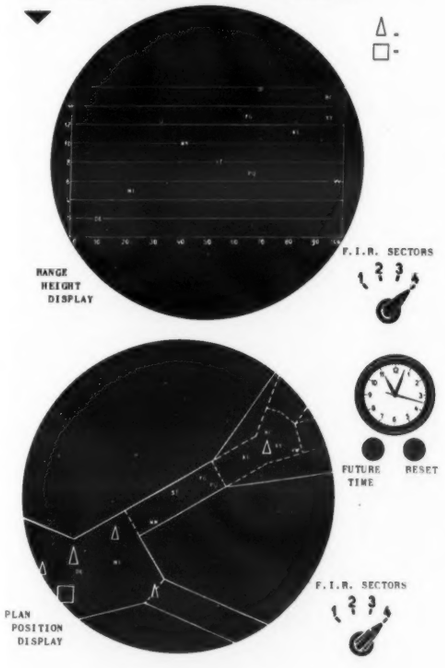


Laboratory model of the S.A.T.C.O. computer.



Mock-up of the display and control panels. Flight data can be transferred to an adjacent control centre by pushing the button next to the strip to be transferred, selecting the control centre on the lower panel, and pushing the "Execute" button.

The "clear-view display" unit consists of two screens showing the position of the aircraft in three dimensions, and can be switched to any one of the region's four sectors. The upper screen displays range and height while the lower is a plan position display. An aircraft is represented on the screens by the last two characters of its call-sign. The information presented is not a pure radar picture but is derived from the computer. The clear-view display may also be set for a future time situation prediction by a clock-dial in steps of one minute up to a maximum of 30 minutes.



by another control centre. The S.A.T.C.O. control system is based on an artificial block system which divides the airways and approach tracks in the terminal areas into a number of small blocks; this method is employed only in the computer, and no extra beacons or charts are required. Each block in the system represents a small section of the air space, with a length of three nautical miles, a vertical dimension of 1,000 feet and a lateral dimension equal to the airway or, in the terminal area, the specified flight paths; the flight level runs through the centre of the block.

The flight path of the aircraft is thus thought of as a series of blocks, each of which is either "occupied" or "reserved" for the aircraft during a period of time predicted by the dead reckoning computer. A reserved block is one which the aircraft is about to enter or leave and which is closed to other aircraft in order to achieve the required separation. Under visual flight conditions there would be one reserved block on each side of the occupied block, under radar there would be two reserved blocks, and under procedure control there would be four reserved blocks on each side of the aircraft.

Blocks occupied by flight paths, together with those reserved for separation purposes, and the times during which they are occupied are recorded on the magnetic memory drum. The flight path of a new aircraft entering the system can thus be checked against those already in the system to avoid conflicts.

In these calculations the geographical location of the blocks and the separation standards in force are constant factors, while the variables are the times at which the blocks will be occupied, and alternative flight paths.

The speed of the S.A.T.C.O. equipment permits the calculation of flight paths to be made in approximately 0.25 seconds and clearance calculations, depending on the number of aircraft in the system, will be made within a maximum of 6 seconds. Display times average about two seconds, but several displays may be operated simultaneously. Initial radar detection requires about 7 seconds, and approximately 5 seconds are required for subsequent checks of the aircraft's position. If more than one automatic tracking radar is used the data rate will increase accordingly.

The accuracy of the equipment depends primarily on whether radar is being used or not; when using radar the accuracy of position and speed are in the order of $\pm$ 2.5 percent, but without radar this will depend largely on the accuracy of wind forecasts. Aircraft speeds will be given to the nearest five knots, distances along airway sections to the nearest nautical mile, and tracks and wind vectors to the nearest five degrees; times will be given to the nearest minute or if required to the nearest half-minute, and heights in units of 100 feet.

The capacity of the system can be matched to the requirements of a particular air traffic control centre. The standard alternatives provide for a storage capacity of 200 flight plans, permitting the processing of 64 flights at a time or, alternatively, for a capacity of 500 flight plans for the simultaneous processing of 128 flights.

The Boeing Jet Transport Spares Provisioning Program

By Ward E. Parsons, Spares Manager, Transport Division,
Boeing Airplane Company, Seattle

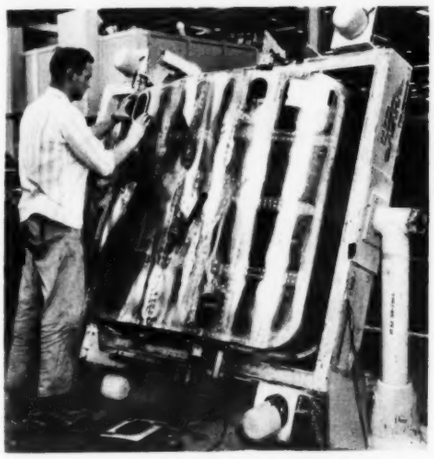
The delivery of America's first jet transport —the Boeing 707—to the commercial airlines this year will also mark the advent of one of the most comprehensive spares provisioning programs ever offered with a new aircraft.

At present, Boeing jet transport sales total 162 aircraft on order by 14 of the world's leading airlines. These aircraft include all members of the Boeing jet "family"—Model 707 *Jet Stratoliners,* Model 707 *Intercontinentals* and the latest addition, the Model 720 intermediate-range aircraft. Boeing Airplane Company has invested millions of dollars in the development of these aircraft, and the airlines have invested additional millions in their orders for them. Because these jet aircraft are such a gigantic step forward in the field of commercial aviation, the accompanying spares program must be equally advanced, in order to keep them operating at their full capacity with a minimum of ground time outside of the normal overhaul periods commensurate with good safety practices.

The major problem confronting Boeing in the jet transport spares picture was how to ensure that our customers could stock a reasonably small but adequate spares inventory and yet be certain that additional parts would be quickly and easily obtainable if needed. Our new spares program, we feel, is the answer.

All departments at Boeing that are involved in the spares picture have been organized administratively or functionally so that spare parts orders will be processed by the most expeditious means. These departments include Spares, Traffic, Shipping, Production Engineering, Engineering Service, Accounting, Materiel, Stores and Manufacturing.

At the heart of our program are our spares engineers. They are all graduates carefully selected for their background in this field, with additional thorough training in spare parts and field service. They also "live" with the various 707 projects so that they will have a first-hand knowledge of the development of the "family" and have access to all engineering data.



Spare parts for the Boeing 707 are manufactured concurrently with production parts. Shown here is a cargo compartment door.

By reviewing each drawing as it is released by the engineering project these engineers select the parts that are potentially replacements or spares. These are then put into International Business Machine cards for review by airline provisioning personnel.

The spares engineers assign an estimated service life ("E.S.L.") to each part, based on Boeing's experience in large jet aircraft manufacturing and service, including the B-47, B-52, KC-135 and the prototype 707. For the parts with a long "E.S.L." it is not recommended that the part be put into stock until the aircraft have been in service for some time. Nor is the airline expected to buy for its initial stock each part that is included in the cards.

The company also has established a line of publications tied directly to the spares program which will enable the airlines to keep up to date on changes and further advancements which might occur in the program. These include, first of all, a Supply Procedures Document which contains all agreements made with the customer relative to the spares picture, minutes of meetings held on the subject, delivery schedules, shipping methods and an outline of the Boeing spares system. A Spares Newsletter, published as conditions warrant, will immediately notify the customer of any changes in the procurement of raw materials affecting the spares picture, so that he may act accordingly. An illustrated parts catalog also will be published, containing an exploded view of each part, its part number and nomenclature.

As a further aid to the airlines in planning their spares inventories Boeing is providing a combined parts usage report consisting of information on actual parts usage gathered from various airlines and compiled and tabulated into one report. This compilation should prove an invaluable addition to the

Spares engineers check each engineering drawing to determine which items shall be classified as spares and fix their estimated service life *(left)*, which is then punched in I.B.M. cards *(right)*, together with other characteristic details, such as parts number, vendor code number, price, etc.

airline's knowledge in planning for parts requirements.

The key to the new spares provisioning system is the use of high-speed I.B.M. equipment. With this equipment the entire spares program can be conducted through the use of only three sets of I.B.M. cards. These are categorized as primary, supplemental and microfilm.

The *primary data card,* as the name implies, carries the basic data on its corresponding part. Each system on the aircraft is designated by a single letter conforming to the designations carried in "A.T.A. Specification No. 100". This is followed by numbers designating parts within the system itself. The cards also carry the price of the part (for all Boeing-designed items), a vendor code number for units manufactured by suppliers, and a number for parts which the airline can fabricate easily and economically from raw stock. Then an "E.S.L." is listed for rotable items (those which are removed on a periodic basis for overhaul), repairable items (units which upon becoming unserviceable may be restored, but do not fall into the rotable classification), and expendable items (those which are discarded upon becoming unserviceable). No "E.S.L." is carried for insurance items (not required for routine maintenance), multiple source and vendor items. Additional information which will be carried on the primary data card includes whether or not microfilm data are available for the part, Boeing part number, the number of the revision if any are made in the card, the part category of the item (rotable, expendable, etc.) and so on.

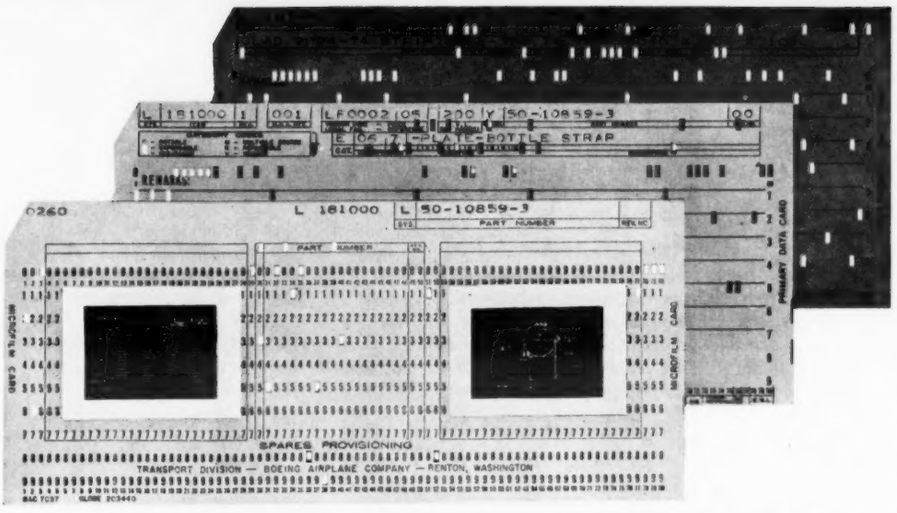
The *supplemental data card* will carry the system and item numbers and a sequence number relating it and any other supplemental cards which give data on the particular part. The aircraft on which the part will be used will be indicated, together with a reorder lead time code and a date on which Boeing should receive the initial provisioning order so as to be certain of meeting previously established shipping schedules. Also included will be a wear-out rate, additional data and remarks.

On the microfilm card will appear the system, part and revision numbers as on the other cards, together with an isometric drawing of the part on a microfilm insert. A second insert contains descriptive information pertaining to the part, such as the material of which it is made and the method used, what mechanisms it contains and the type of wear and usage to which it is subject. The card can be inserted in a viewer for reading.

As an alternative to the provisioning card system, or "deck" as it is sometimes called, Boeing is offering to interested airlines a second system which would put all the information contained on the cards on to 35-mm slides for use in a standard 35-mm projector.

An I.B.M. tabulation sheet of the primary and supplemental cards in item number order, placing each part in breakdown sequence, will be prepared and furnished to the airlines, together with a wiring diagram of the I.B.M. board used to produce the tabulation. In addition, Boeing will send an I.B.M. tabulation by part number sequence, cross referenced to the item number assigned each part and to its location in the system.

On insurance items Boeing is providing the airlines with a special document containing sketches of the aircraft structure. When parts are needed, the airline simply shades the appropriate area covering the damaged section and sends it to Boeing. Company spares engineers will study it, select the parts needed for repair and ship them as a complete kit.



Each spare has a set of I.B.M. cards, consisting of a primary data card, one or more supplemental data cards and a microfilm card. The set contains all essential data and an isometric drawing of the item concerned.

Author *(standing)* and R. S. Moore (Boeing Transport Division) demonstrate to airline engineers the practical use of microfilm cards: Jean Hameury, Air France *(left)*, John Mills, Qantas *(second from left)*, Ivor Lusty, B.O.A.C. *(far right)*.

Boeing also supplies airlines with conventional spares lists prepared by an I.B.M. rapid printer.

Outstanding feature of the Boeing I.B.M. provisioning system is its flexibility. If, for instance, an airline wants to know only which parts are repairable items, the I.B.M. "deck" is run through an I.B.M. sorter, which comes up with the required information in a few minutes. The airline can also set up mechanical inventory control and ordering systems for additional cost reduction and faster service.

The system also includes a spare parts ordering method. If the airline desires, Boeing will furnish it with a "deck" of preprinted I.B.M. cards for each item of spare parts. As parts are required, the appropriate card is filled out as to quantity desired and sent to Boeing for processing. At Boeing it is run through the I.B.M. system which treats it as a regular purchase order. Inventory control, manufacturing releases, packing sheets and invoices are all mechanized processes at the company's Transport Division. Even so, the company is developing a method whereby orders can be transmitted by telex to the Transport Division. These will be received on a perforated tape which will be placed in a converter and reproduced on I.B.M. cards for use in the I.B.M. system. This will permit immediate follow-through on orders.

In case the customer should not wish to install mechanical sorting and handling equipment, the I.B.M. cards have the information printed on them as well as punched into them.

Despite the advance planning by Boeing and its customers in the matter of stocking spares, there is bound to be a certain amount of overstocking of items in some areas. Consequently, Boeing has agreed to act as a "clearing house" for disposing of these excesses. For instance, if one airline is overstocked with a certain item while another airline finds itself in short supply, Boeing will put that airline in touch with the customer having the oversupply. This system will enable inventory investments to be kept at economical levels.

American Airlines' Automatic Reservations System

In 1952 American Airlines Inc. introduced an electronic system known as the *Magnetronic Reservisor* to speed up reservations inquiries at the La Guardia reservation centre. Four years later, in August 1956, when the airline moved its booking centre to New York's West Side Airlines Terminal, it installed an improved model of the Magnetronic Reservisor, which—like its predecessor—was built by the Teleregister Corporation, a subsidiary of the Ogden Corporation.

Basically the Magnetronic Reservisor is an electronic computer working at high speed, which is connected with the "key" sets in the agencies, and which stores, transmits, checks, etc. reservations data. This not only saves time and labour, but also enables information to be provided almost instantaneously.

If, for example, a prospective passenger telephones one of the American Airlines' 150 New York agents, the latter need only insert a small metal plate into his key set and manipulate a few buttons (thus passing through data such as date, flight number, etc. to the reservations centre). Within a few seconds he has full information on available seats, departure and arrival time and other data. All these details for all of the company's scheduled flights are carried in the memory—a magnetic drum—of the Reservisor.

As a first step towards the incorporation into the Reservisor system of all the major cities served by American Airlines, the Buffalo reservations office was connected to the New York Magnetronic Reservisor by a remote control system in 1955. Booking agents in Buffalo can therefore obtain answers to queries on scheduled flights just as speedily as their New York colleagues.

The "brain" of the system consists of 2,800 electronic tubes and a magnetic memory drum capable of storing information on 2,000 flights per day—roughly double the number which American Airlines now operates—*for a period of 31 days*. Up to 200 agents' sets in the New York area can be connected direct to the Magnetronic Reservisor, while the number of "outside" offices can be multiplied at will. Average handling time for each inquiry is half a second, though the Reservisor can deal with transactions at the rate of up to 10 per second, and answer more than 10,000 requests for information an hour. So that it can also cope with the large-capacity jet aircraft of the future, it is designed to keep track of up to 255 seats for each flight. Finally an automatic checking system ensures that any errors occurring are immediately corrected.

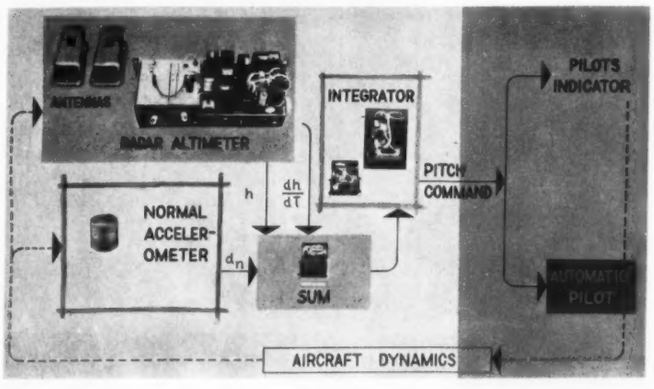
The Magnetronic Reservisor at American Airlines' New York reservations office. In the rear, underneath the clock, is the system's "memory", the magnetic storage drum, on which all necessary reservation data for all American's scheduled flights are recorded for one month. The system's mechanism is constantly checked by a representative of Teleregister Corporation, a subsidiary of Ogden Corporation, which built the Magnetronic Reservisor.

The "key" set, connected with the Magnetronic Reservisor, is installed between these two agents in one of American Airlines' 150 New York agencies. The agents need only operate a few push buttons, and within seconds the Reservisor gives them any desired information on any of the company's scheduled flights for the following 31 days.

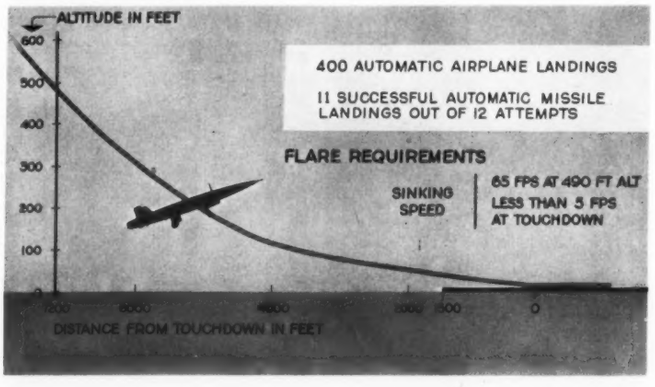
A fully automatic landing system

The Autonetics Division of North American Aviation, Inc. has developed an automatic landing system during development of which more than 400 fully automatic landings were made by manned and unmanned subsonic and supersonic vehicles. Originally designed for the North American X-10 unmanned supersonic research aircraft, the new A.L.S. automatically brings the aircraft down a predetermined path to touchdown. For this purpose it passes the requisite signals to the autopilot and can trigger a descent at any altitude up to 500 ft. Rate of descent is controlled by flare signals which determine the proper space path for descent and provide a predetermined low rate of descent at touchdown. Under conditions of a 10° glide angle approach, the X-10 rate of descent is reduced from 4,200 ft./min. to 1—2 ft./sec. on touchdown.

Changes in altitude and acceleration data are passed from the radar altimeter and the normal accelerometer to the summing and integrator equipment, where they are converted into pitch commands for the automatic pilot.



Results of landing tests with the X-10. The altitude of the aircraft is plotted against the distance from touchdown. Rate of descent at 490 ft. altitude is 65 ft./sec., but less than 5 ft./sec. at touchdown.



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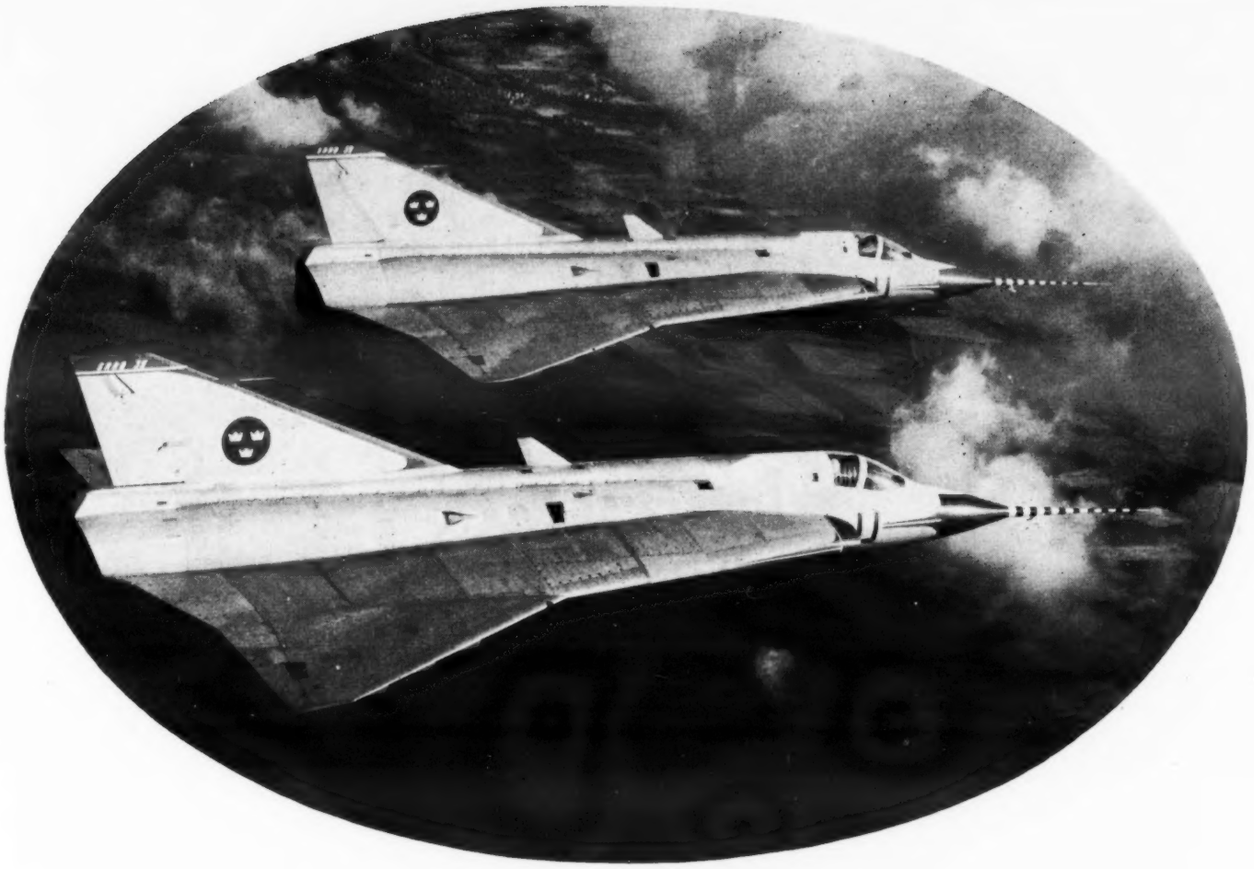


Ten vital facts about the SAAB-35 "Draken"

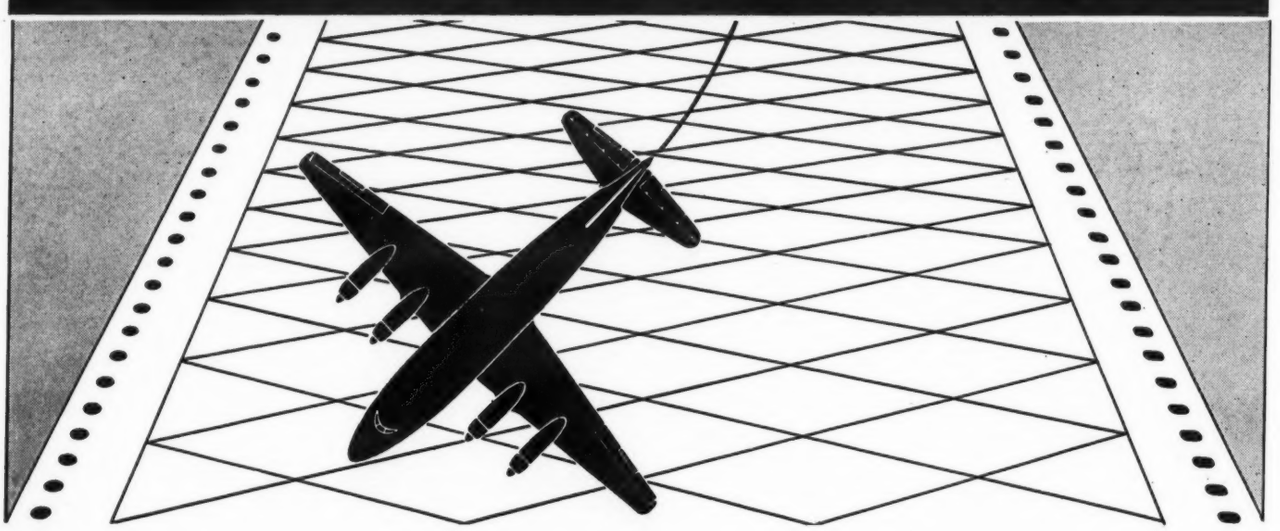
1. The Saab-35 is already in quantity production as the Swedish Air Force's new standard combat aircraft.
2. It has a top speed close to Mach 2 and very impressive climb performances.
3. It has a greater useful speed range than any other aircraft.
4. The Saab-35 can operate from smaller and more shrouded airfields than any other supersonic fighter.
5. It has full radar and navigation equipment for all-weather operations.
6. It is equipped with the most modern fire-control equipment for collision-course tactics.
7. The Saab-35 is equally suitable for interception and ground attack purposes. In the intercepter role it carries air-to-air rockets or guided missiles, and heavy-calibre guns. For ground attack use, it carries a heavy load of air-to-ground rockets or bombs.
8. It is designed for economical production without the use of highly expensive tooling or specialized heavy machinery.
9. The Saab-35 has been developed by a large industrial enterprise with more than 8,000 employees—including 1,500 engineers—and the most modern technical resources.
10. The Saab-35 is backed by 10 years of experience in large-scale production of high-speed jet fighters.

SAAB

SAAB-35

SVENSKA AEROPLAN AKTIEBOLAGET • (SAAB AIRCRAFT COMPANY) • LINKÖPING • SWEDEN

Situation under control



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Design Principles of the Draken Supersonic Fighter

by Erik Bratt, Linköping, Sweden

The author (right) with Chief Test Pilot Bengt R. Olow.

The prototypes of the J 35 *Draken* have been undergoing flight tests for more than two years, and the first production model made its maiden flight on February 15th. Our work is thus changing over from the more or less fluid problems of the project stage to the stern realities of quantity production.

The value of our design is easy to assess today, after the event. Project work on the J 35 began more than eight years ago, and the design has not undergone any major modifications since May 1952. The following account of the development work on the *Draken* will reveal, in particular, how we arrived at the aircraft's present configuration.

The problem

Work on the project began on a modest level in 1949, when the Royal Swedish Air Force was looking around for a successor to its standard J 29 fighter. The requirement was for a fighter which should be capable of intercepting an attacking near-sonic jet bomber and which therefore should have a speed of roughly Mach 1.4 to 1.5 (Mach 1.7 to 1.8 in 1956). In addition the fighter was to be able to climb to A altitude at subsonic speed (A + 2 km in 1956) and to an altitude of 10 km (32,800 ft.) in t seconds (t/2 in 1956). Finally, it had to be suitable for operation from runways used by the J 29. All this with adequate armament and comprehensive electronic equipment.

In order to realize the full impact of these requirements, we must bear in mind the position in Swedish aeronautical engineering at that time: the J 29 was just going into production, design work on the A 32 was beginning, and except for one small tunnel for supersonic tests, there were only subsonic wind tunnels available. At that time, too, there were no swept-wing fighters in squadron service. These did not appear until a few years later: J 29 (Sweden), MiG-15 (U.S.S.R.), F-86 (U.S.A.). And the only aircraft to have reached supersonic speeds was the Bell X-1 rocket-powered research aircraft.

Our first discussions centred chiefly around the following questions: (1) high or low aspect ratio ? (2) straight, swept or delta wing ? (3) if a delta, with or without separate tailplane ? (4) jet engine with or without reheat ?

Originally we flirted with the idea of a highly swept fighter of conventional layout, which might well have been capable of more than Mach 1 in level flight, but would have had only little internal capacity. At the same time we gave some thought, so to speak " on the side ", to a delta-wing design, but in those days the outlook for deltas in general and for " tailless " aircraft in particular was far from rosy. One of the first U.S. deltas, Convair's XF-92, was damaged in a belly landing, and the de Havilland *Swallow* tailless, swept-wing experimental aircraft had crashed when attempting to reach sonic speed. Shortly afterwards Avro's first delta-wing experimental aircraft also crashed during its second flight. We were beginning to realize that greater efforts would be needed in order to meet our programme. The only way to tackle these problems appeared to us to be to design the aircraft —whose cross section was fixed—for minimum total drag in supersonic flight.

The author, chief designer of Sweden's Saab-35 *Draken* single-seat fighter, has been with Svenska Aeroplan A.B. since 1946. In 1949 he designed the Saab-202 research aircraft as a preparation for the Saab-32 *Lansen*, and later the Saab-210 subsonic experimental aircraft with the then revolutionary double-delta wing shape. The latter was finally followed by the Saab-35 *Draken*, for his work on which Mr. Bratt received the Thulin Medal in 1956. Earlier he had been in charge of the testing of the Saab-90 *Scandia* airliner and is the designer of the BHT-1 *Beauty* sports aircraft of 1943-44.

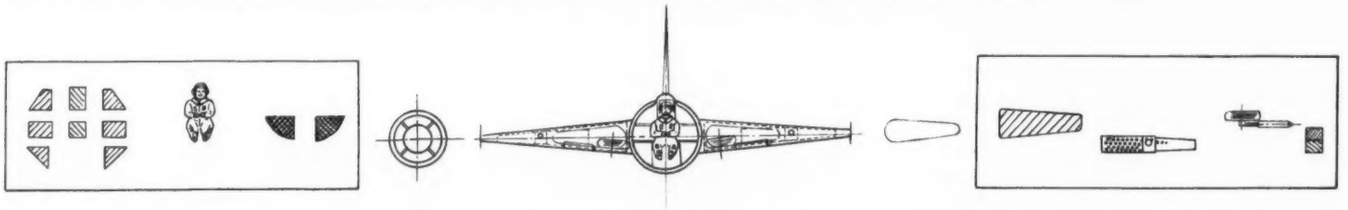
Editors.

Minimum frontal area

As a rule a designer begins by drawing his new aircraft as he thinks it ought to look from the purely aerodynamic point of view. Next he tries to find room inside for the engine, fuel tanks, etc. and thus arrives, via a series of compromises, at a result which meets his specifications.

We, however, grasped the problem from the other end, reasoning as follows: there are certain volumes which we must accommodate in any case and which can definitely not be placed one behind the other, such as the jet engine, wing and rudder unit, and in most cases the air intakes. Allowance must also be made for other volumes or section areas, such as the pilot, fuel tanks, undercarriage, armament and radar equipment, etc., which can be housed in front of, behind or even inside a component of the first category. These movable volumes (section areas) must then be arranged so as to give the whole aircraft a minimum frontal area. They can either be placed one behind the other in the fuselage, in front of the engine *(alternative 1)*, in which case the wing

Fig. 1: To obtain the smallest possible frontal area (drawing in centre) the pilot's seat, electronic and certain other equipment were housed in the fuselage *in front of the jet engine* (left-hand diagram). Fuel tanks, main undercarriage and parts of the armament installation were placed in the wing *behind the air intakes* (right-hand diagram).



selected is very small with very extensive high-lift devices and a separate tailplane; or *(alternative 2)* some of the movable section areas are put into the wing, for example, fuel tanks and undercarriage behind the air intakes.

In alternative 1, that of a more conventional design, we foresaw certain difficulties: doubtful flying performance, danger of the wing's and tailplane's being too elastic, possibility that shock waves originating from other parts of the aircraft might strike the tailplane, and less rational utilization of volumes. *We therefore decided on alternative 2 (Fig. 1).*

- Jet engine, pilot, electronic and various other equipment are housed in the fuselage, where the engine section covers all others.
- Air intakes, fuel, undercarriage, armament and certain other equipment are in the wing, where the frontal area of the air intakes covers all others.

An aircraft with low overall drag must also have low interference drag and must therefore be neither a high-wing nor a low-wing design. The *Draken* was thus designed with a mid-set wing.

Span is determined by ceiling in subsonic flight

The basic drag of a high-speed aircraft (at very small angle of attack) and the thrust of a jet engine always combine to ensure that excess thrust is greatest at 11 km (36,000 ft.) altitude. This is due to the favourable effect of low temperatures on engine thrust. Above 36,000 ft. temperature remains practically constant, but air density continues to decrease, so that drag and thrust both fall off with increasing altitude.

Induced drag is proportional to the square of the aircraft's span loading but inversely proportional to the air density. If span loading is selected so that induced drag at 36,000 ft. is relatively small at critical Mach number (as is usually the case with most aircraft of this class), the aircraft's subsonic ceiling depends primarily on the excess thrust at 36,000 ft. (at critical Mach number) and on the span loading. If the gross weight is fixed, and the engine's thrust behaviour at greater altitudes is known, then the required span can easily be obtained by approximation calculations *(Fig. 2)*. We now know the aircraft's section and its span.

Designing the supersonic wing for lowest total drag

The next step is to design the wing of known span in such a way that it will have

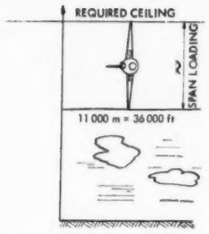


Fig. 2: The required subsonic ceiling and excess thrust at 36,000 ft. determine the aircraft's permissible span loading and hence—as gross weight is known—its span.

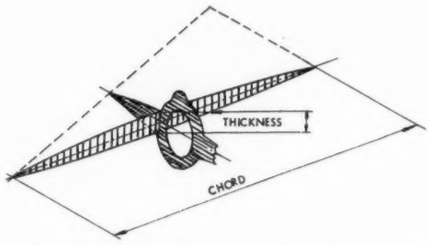


Fig. 3: Drag at supersonic speed consists primarily of: 1—friction drag (proportional to wing area); 2—wave drag (inversely proportional to wing area).

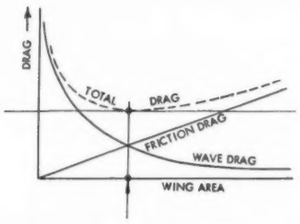


Fig. 4: Diagram used for obtaining optimum wing area for minimum total drag in supersonic flight.

minimum drag at supersonic speeds. In our first calculations we ignore the induced drag and make use of certain approximations to help us give our known wing section a tentative chord. The wing area naturally varies with this chord.

The drag of a wing in supersonic flight is built up partly of friction drag (in principle of the same nature as at subsonic speeds) and partly of wave drag (supersonic drag). Friction drag is proportional to the size of the surface in the air flow, i.e., to wing area, and thus *increases* with the chord. On the other hand, wave drag is proportional to the square of the section area, but inversely proportional to the wing area. As we regard the section area as constant, wave drag thus depends solely on wing area; it *decreases* as the chord increases *(Fig. 3)*. *The combination of friction drag and wave drag is hence a maximum-minimum problem, as shown in Fig. 4.*

Here it must be remembered that total drag at supersonic speeds develops in such a way that it cannot be reduced below twice the friction drag (in special cases 1.5 times the subsonic drag).

The optimum supersonic drag is obtained for a given ratio of section area to wing area, in other words for an exactly calculated value for *thickness/chord ratio*. For Mach numbers between $\sqrt{2}$ and 2, we found the most favourable thickness/chord ratio to be between 4.5% and 5%. It also appeared desirable to keep the thickness/chord ratio constant along the span.

If we now aim at a wing with very small chord at the tips, we get as a first draft the triangular or delta shape. The above-mentioned quantities—section, span, thickness/chord ratio—might thus have settled the wing configuration but for certain other conditions which must be met, notably those of landing performance.

Landing performance

Assuming the thickness/chord ratio as constant, the wing configuration so far arrived at cannot be modified without at the same time modifying the section area. The question arises, however, of whether the wing produced in this first attempt is the right size to give the desired landing speed. Further investigation may reveal one of three conditions: 1—the wing *is* the right size; 2—it is too small; 3—it is too big.

If the wing is found to be the right size, no further modifications to its basic design are needed. This means that the pure delta shape can be used, though it is by no means equivalent to saying that all aircraft with "pure" delta-wing configuration will be optimum in both supersonic flight and landing.

If the wing is found to be too small, the chord must be increased, without modifying the section area. The thickness/chord ratio will thus fall below its optimum, and total drag at supersonic speeds will *rise*.

If, however, the wing is found to be too big—as was the case in our first design—it is possible to reduce supersonic drag still further, by simultaneously reducing the wing area *and* the section area. But in our original thinking (alternative 1) the section area was selected to enable the fuel tanks, parts of the armament installation, the undercarriage and other components to be placed behind the air intakes. It appeared to be more difficult to reduce the section area in this region than further outboard, near the wing tips *(Fig. 5)*. This gave rise to the broken leading edge, the so-called double-delta wing shape. It was not until we discovered this solution to the configuration problem that we were able to obtain an optimum wing for both supersonic speed and landing speed.

Low aspect ratio and double-delta shape

Our investigations led us to a delta wing with extremely low aspect ratio. Hence a separate tailplane with elevators or an all-flying tail were not required; in fact they would have been a handicap. This disposed of many problems connected with tail flutter, complicated mechanisms, unfavourable aero-elasticity, etc. With this low aspect ratio, a fin placed on the tailplane would merely have caused instability, as the variation in downwind angle with variations in the wing angle of attack is very great.

Consequently we decided to make the control surfaces on the wing trailing edge serve as both ailerons and elevators (so-called elevons). This reduced the number of surfaces needed for longitudinal and lateral control by half, while directional control was provided in the conventional manner.

Lift-augmenting flaps to reduce landing speed cannot be used with a delta wing, but landing speed can be safely decreased by bringing the aircraft down at a slightly larger angle of attack than is usual. This, however, involves certain difficulties in the design of the pilot's seat and the fuselage nose. In the J 35 the forward fuselage was slightly drooped, and the cockpit moved well forward, so that the pilot can see the runway throughout the approach and touchdown process.

Stability

The question of stability in a delta-wing aircraft with such low aspect ratio was extremely tricky during the early years of the project stage. We began by making a few simple wind tunnel tests at low speeds, principally with flat plates, and obtained good results which were later confirmed. We then studied the behaviour of a small captive model (scale 1:8) powered by a midget jet engine. These flights showed us the limits within which we could vary the centre of gravity and also coincided satisfactorily with the results of the wind tunnel tests we had meanwhile made. It is interesting to note that the flights also confirmed what we had found in the wind tunnel as regards the value of a tailplane: when the model was fitted with a " stabilizer ", it simply became uncontrollable.

Landing qualities

One of the foremost qualities of a delta wing of very low aspect ratio is its superiority in low-speed flight and during landing. Every aircraft with conventional wing and tailplane has a fairly clearly defined point of stall. It is therefore hazardous to land such an aircraft at minimum speed: if the stall condition is reached at slightly too high an altitude above the runway, the result is an unpleasant pancaking. If the aircraft turns in to land at too low a speed, it can tip over one wing. These dangers are eliminated or at any rate greatly reduced in the delta-wing aircraft of low aspect ratio. It is not possible to get into a dangerous stalled condition in order to obtain the lowest possible speed, since the extreme angles of attack required for this condition are not obtainable during landing. The aircraft therefore remains fully controllable with all control surfaces (*Fig. 6*).

L/D ratio

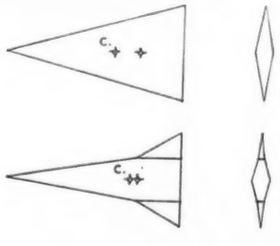
It is sometimes argued that aircraft of low aspect ratio have a serious disadvantage in that the drag induced by the production of lift is too high. This view is incorrect. As the initiated well know, induced drag depends solely on the square of the span loading (naturally assuming that the " ellipse factor " is constant throughout the speed range in question).* All aircraft with small span (in relation to their weight) have high induced drag, regardless of their wing area, and vice versa.

Induced drag is of decisive importance in the aircraft's transport economy (which depends on optimum L/D ratio). Optimum L/D ratio is obtained at the speed at which basic drag (for zero lift) and induced drag are equal. As the ratio of aircraft drag to engine thrust constantly changes with increasing altitude, because of the decreasing air density and falling temperature, and the optimum operating altitude for high subsonic speed is 36,000 ft., it may be assumed that the most favourable conditions for good transport economy will be found at this altitude and at speeds of just under Mach 1.

In addition the dynamic pressure of the optimum L/D ratio is proportional to the ratio between the span loading and the square root of the wing area. If all these values could be selected so that the optimum L/D ratio is obtained at the critical Mach number and at 36,000 ft., two optimum conditions could be combined. This is exactly what has been achieved in the J 35, thanks to its low aspect ratio: the dynamic pressure at which the aircraft's optimum L/D ratio is obtained is only insignificantly above the dynamic pressure for the critical Mach number at 36,000 ft. for the full load case, and slightly below this figure for the smaller load case. This explains why the *Draken* is equally suitable for supersonic flight and for high transport economy and low landing speed.

* The induced drag (measured in kg or lb.) must not be confused with its non-dimensional coefficient. The former [$D_i = (W/b)^2/q\,\pi\,e$] is *independent* of aspect ratio Λ (or b^2/S), the latter *includes* the aspect ratio [$C_{Di} = C_L^2/\pi\,e\,\Lambda$], where e is the " ellipse factor ".

Fig. 5: From the pure delta to the double delta... which offers the following advantages: 1—reduced frontal area with optimum wing area; 2—improved volume and better sweep in the inboard portion of the wing; 3—centre of gravity closer to centre of pressure (C.); 4—favourable distribution of areas in the longitudinal direction (area rule); 5—air intakes well forward.



The c.g. position

A pure triangular wing with low aspect ratio has its centre of pressure fairly far forward in the subsonic range. This centre is even well ahead of the wing structure's centre of gravity. However, the centre of gravity of the whole aircraft should lie at the centre of pressure or slightly ahead of it, an elementary requirement to ensure static stability in aircraft without separate tailplane. Fuselage and engine must therefore be shifted until centre of gravity and centre of pressure coincide. The problem is greatly simplified if a wing configuration is chosen in which centre of gravity and centre of pressure lie closer together. Our efforts in this direction resulted in a basic configuration corresponding to that of the J 35.

The air intake

From the very beginning it seemed obvious that to give optimum results, the air intake would have to be placed as far forward as possible. We decided against an intake in the fuselage nose because of structural difficulties in housing the radar antenna, and finally settled on intakes at the sides. Tests in large and small wind tunnels and at all imaginable speeds were then made, and as a result a number of modifications to details were found to be advisable. We paid special attention to the somewhat controversial question of how the air intake would behave at sonic and supersonic speeds. But quite early in our investigations we discovered that good functioning in the supersonic range could be obtained if the intake lay well ahead of the fuselage maximum width, i.e., in a region in which the oncoming air is accelerated. Flight tests later fully confirmed these assumptions.

Secondly there was doubt about whether the air intake would produce the right pressure distribution in front of the engine; wind tunnel measurements proved disappointing. To overcome this difficulty, we introduced, shortly before the prototype's first flight (1955), two bulges which have been fully incorporated in the air ducts in the production model.

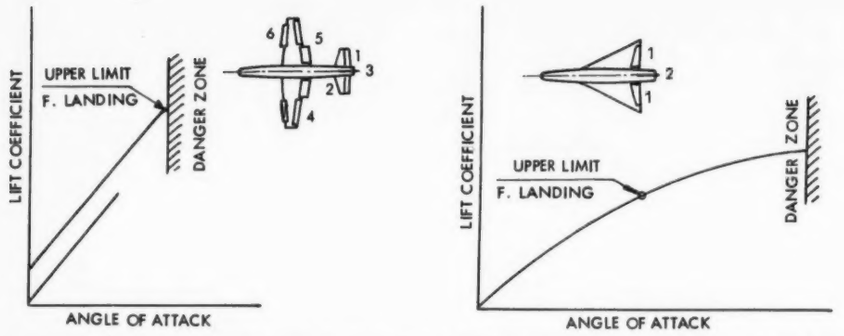


Fig. 6: Lift coefficients of a conventional aircraft (left) and a delta-wing aircraft (right), with upper limits for landing and danger zones for flow break-away. Whereas a conventional aircraft requires six different controls (1—elevators; 2—movable tailplane; 3—rudder; 4—ailerons; 5—landing flaps; 6—slats), a delta-wing aircraft manages with two: 1—elevons; 2—rudder.

Variants

The double-delta shape and, above all, the easily dismantled outer wings make it possible to adapt the same aircraft design for a variety of tasks. If long range at a given altitude is required, different outer wings can be fitted, which would perhaps not give the best results if very high speeds were required. In addition, extreme centre of gravity travel for certain load variants can be compensated by appropriate changes in the outer wings. We are therefore in a position to develop several versions of the aircraft type and can keep the basic design up to date for many years.

The Saab-210 experimental aircraft

In order to test our ideas in practice, the Swedish Air Force and SAAB decided to build a reduced-scale ($1:\sqrt{2}$) experimental aircraft to be used only for tests at low speeds. The only jet engine then suitable for this light aircraft was found in Britain: the Armstrong Siddeley *Adder*, forerunner of the *Viper*. The Air Force bought two of these engines, which however were too weak for the required purpose as they had only about 6% of the thrust of the present J 35 engine. To carry the required measuring equipment, the aircraft had to be designed for very low wing loading and low weight (two contradictory requirements), in order to keep take-off distance within acceptable limits. Design work began in May 1950, and the aircraft was ready to take off in December 1951. However, the first flight had to be put off until February 21st, 1952, because of bad weather.

Within the first week, flight tests in the Saab-210 revealed the exceptional promise of this aircraft type at low speeds. A few months after the first flight the Air Force awarded a contract for the construction of a fighter based on these principles. Tests in the Saab-210 continued, however, and proved of decisive aid in the overall J 35 project. Such questions as centre of gravity position and stability at low speeds were solved during the some 1,000 test flights carried out over a number of years.

Supersonic wind tunnel tests

The Saab-210 could provide information only about qualities at low speeds. To enable investigations to be made at high speeds, SAAB built a supersonic wind tunnel to its own design, beginning it at about the same time as the Saab-210. The first experiments at sonic and supersonic speeds were made in this tunnel a few months after the 210's first flight. Additional tests were also made in the United States, and a little later other Swedish wind tunnels became available. In the course of the years, therefore, a very great deal of research work was done on this aircraft type, and no effort was spared to investigate the aircraft's qualities in all flight conditions before the first flight took place.

Design details

Electronics and armament : It should first be stressed that armament and electronics form a common system which must be developed parallel with the aircraft project. Particularly important is an automatic flight control system, not only to lighten the pilot's task but also to provide a vital link between communications equipment and armament.

Undercarriage : In the retracted condition the undercarriage units are compressed, so as to occupy the smallest possible volume. This is not done by compressing the air in the sprung leg (which would complicate locking) but by drawing the hydraulic fluid into a storage chamber above the undercarriage.

Control system : Two duplicate hydraulic systems are provided. Both operate the vital control surfaces—elevons and rudder—but only one of them is used for the other, less vital equipment. As both systems would be put out of operation in the event of engine failure, a reserve pump driven by a ram air turbine roughly 10 ins. in diameter immediately comes into operation in such circumstances. The pump is sufficiently powerful to control the aircraft both at supersonic speed and at landing speed. The auxiliary turbine is automatically extended into the air flow when the pressure in one of the hydraulic systems fails.

Fuel system : As the fuel constitutes a relatively large portion of the gross weight and hence decisively influences the position of the centre of gravity, its flow is controlled by means of a very simple mechanical-electronic metering system. The object is not merely to keep the fuel c.g. close to the aircraft's c.g. at all times, but also to enable the centre of gravity of the whole aircraft to be controlled in such a way that it gradually moves rearwards during the first half of the flight. This brings it into a more favourable position for combat and supersonic manœuvres. During the last flight phase it is then moved forward again, so that for landing it is in roughly the same position as for take-off. Nevertheless the aircraft can be landed with fuel tanks half full, even with the fuel in most unfavourable position, the only drawback being that stability is slightly reduced.

Electrical system : Power supply presents a definite problem in an aircraft operating at such high altitudes. At first we tried d.c. generators and converters, but encountered arcing and low efficiency at high altitudes. We therefore looked around for alternators but could find none suitable. A number of foreign manufacturers were in the same position as ourselves at that time. As alternators must work with constant frequency—i.e., rotary speed—they need a device which converts the somewhat sharply varying engine rev. speed into a constant rotary speed for the alternator. At that time there was a flood of suggestions of how such a device should be made. It was not easy to choose the best principle and to judge which manufacturer would succeed in bringing out his design in time. Our choice finally fell on the American firm of Sundstrand. The Sundstrand gear drives a 20kVA Bendix generator and, in conjunction with rectifier and emergency alternator, probably provides the lightest source of electric power obtainable today.

Flight tests

The first aircraft took off on its maiden flight on October 25th, 1955, and completed it according to programme. Unfortunately, after only a few more flights, a period of bad weather set in, grounding the aircraft for some six weeks. Flying was resumed in mid-January 1956, and soon the aircraft was going supersonic on every flight. The second prototype flew in mid-March, and the third three months later.

Flight testing gave even better results than we had expected. The aircraft revealed very short take-off and landing runs, subsonic and supersonic drag were lower than predicted, control surface efficiency in the supersonic range better, etc. Of course, there were also disappointments, but they were insignificant, being merely of the kind which are practically unavoidable in the testing of new aircraft and engines.

We were well pleased. When a country as small as Sweden undertakes such an ambitious project, it cannot afford to fail. And we are all proud of having achieved the desired result.

Rockets, Missiles and Space Vehicles

Launching the *Jupiter C* satellite vehicle.

• First U.S. Army satellite in orbit

In the late evening of January 31st at Cape Canaveral, the U.S. Army launched a multi-stage *Jupiter C* rocket, successfully putting *1958 Alpha*, the first American earth satellite, into orbit. From subsequent recordings at the U.S. Navy's Minitrack radio tracking stations it has been established that the satellite, together with the last stage of the rocket vehicle, is orbiting the earth in approx. 115 minutes. Max. height (apogee) of the elliptical orbit is approx. 1,500 miles and min. height (perigee) is 220 miles. The satellite's orbit is in a plane at 33° to that of the equator and traverses the whole of the earth's surface between latitudes 33°N and 33°S.

Official statements give the following picture of the launching of *1958 Alpha*. At 22.48 hours local time (03.48 G.M.T.) the four-stage carrier rocket heaved itself off its launching pad immediately after firing of the first-stage rocket unit, unlike normal launchings where the carrier has remained captive until the full thrust has been built up. After 145 seconds the second stage, comprising a bundle of 11 *Sergeant* solid propellant rockets, took over, and the first stage separated and fell into the ocean. At the moment of firing the second stage, the entire vehicle had adopted an almost horizontal attitude at a height of about 300 miles. The vehicle was then accelerated until burnout and separation of the second stage. The third stage—three solid propellant *Sergeants*—and the fourth stage—a single *Sergeant*—gave the bullet-shaped satellite a final velocity of approx. 18,000 m.p.h. The entire ascent, from firing of the first-stage rocket to bringing the satellite into its orbit, lasted 425 seconds. To stabilize the last three stages during the climb, the Redstone first stage imparted spin to the vehicle, so that the satellite rotates about its longitudinal axis at a constant 750 r.p.m.

The *Jupiter C* rocket used for the launching had a total gross weight of 62,741 lb. at take-off. Its first stage was powered by a specially modified North American Rocketdyne *Redstone* engine which delivered a launching thrust of 83,000 lb. through the use of a new high-energy fuel. Normally the *Redstone* engine works on liquid oxygen and alcohol, while the modified version employed in the *Jupiter C* used liquid oxygen and a hydrazine derivative called hydyne giving a greater specific impulse.

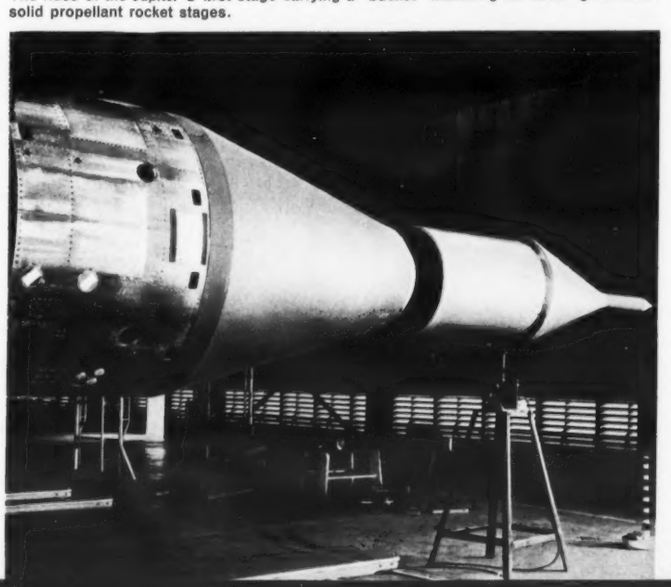
The overall length of the satellite, including the last stage of the launching vehicle is approx. 80 ins., diameter 6 ins., and the weight after final-stage burnout is about 30.8 lb. The satellite body with its measuring equipment has a weight of approx. 18.13 lb., and the burned out fourth stage weighs approx. 12.67 lb. The weight of the satellite's measuring equipment is given as approx. 10 lb. According to an official spokesman, *1958 Alpha* carries the following instrumentation: high-precision meters for measuring surface temperatı res, especially during the ascent; meters for internal temperatures; elements for recording meteorite impacts; measurement of cosmic radiation including a Geiger-Muller counter. The resulting measurements will be passed back to earth by two radio transmitters in the satellite working on frequencies of 108.03 and 108.0 Mc/s, the former having an output of 60 mW and the latter 10 mW. The 108.03 Mc/s transmission, which amateurs were also able to receive, has already ceased, as originally forecast; the 108.0 Mc/s transmitter, which can only be received with the aid of special equipment, will probably function for some 2 to 3 months. The 60 mW transmitter put out a continuous modulated tone. Eight parallel strips of zirconium oxide were mounted on the nose cone to maintain the satellite's internal temperature at between 0 and 50°C during the ascent; without this precaution, temperature variations between −100°C and +400°C would have been unavoidable.

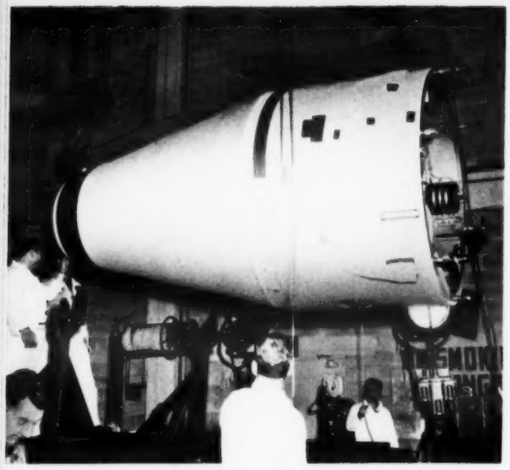
The satellite programme, which has been christened *Explorer*, is under the supervision of Dr. William

The *1958 Alpha* small satellite with the final stage of the carrier vehicle.

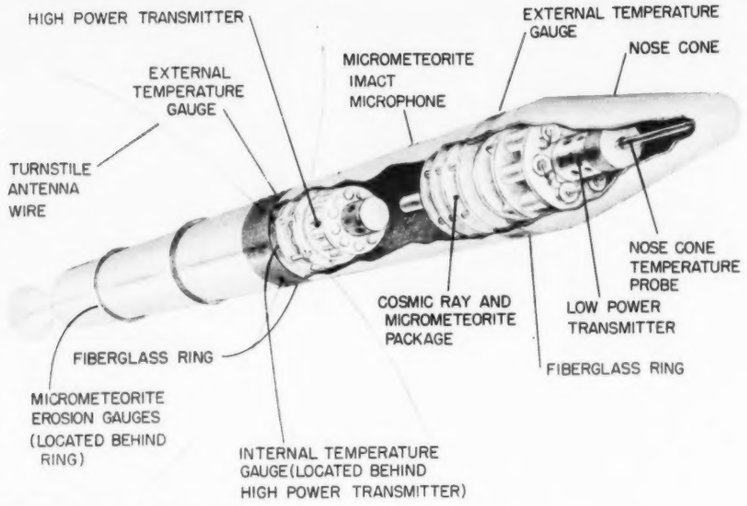
First stage of a *Jupiter C* carrier rocket in the Army Ballistic Missile Agency's workshops at Cape Canaveral.

The nose of the *Jupiter C* first stage carrying a "bucket" mounting for housing the other solid propellant rocket stages.





The nose portion of the *Jupiter C* first stage houses the bulk of the guidance mechanism; the rotatable housing for the second, third and fourth stage rockets (not shown here) is mounted on the tip at left of illustration.



Sectional drawing of the 1958 Alpha satellite.

H. Pickering, Director of the Jet Propulsion Laboratory, California Institute of Technology. Dr. Wernher von Braun of the U.S. Army's Ballistic Missile Agency is responsible for the design and development of the first stage of the carrier vehicle.

Pentagon officials told *Interavia's* Correspondent that the *Jupiter C/Explorer* project grew out of the 1954 *Project Orbiter*. The latter was prepared by Dr. von Braun who proposed the launching of a small satellite with the aid of a multi-stage rocket using a 75,000 lb. thrust *Redstone* rocket as first stage and clusters of *Loki* solid-propellant rockets for the additional stages. This vehicle would have been capable of placing a 5-lb. satellite in orbit, with more ambitious satellites to follow. Approval of the projet was received from both the Army and the Navy, and Commander George Hoover of the Office of Naval Research was named Project Officer. Development contracts were placed, but the project was suspended in May 1955, pending the Pentagon's decision on the system to be used to launch the satellites proposed for the International Geophysical Year. Eventually the *Vanguard* system was chosen, one of the reasons being that it could be carried through without interfering with a going military missile development programme. By the time *Project Orbiter* was abandoned, the launching vehicle had already progressed to a design almost identical to the *Jupiter C:* a first stage comprising a *Redstone* with elongated propellant tanks, and three additional stages of scaled-down *Sergeant* solid-propellant rockets on the nose. These would have been mounted in a "bucket" to be rotated at the outset to provide spin stabilization for the solid rockets. In fact it may be said that the *Jupiter C* vehicle used to test re-entry problems for the *Jupiter* I.R.B.M. was a direct outgrowth of the planning for *Project Orbiter*. Finally, the Washington Correspondent points out that actual satellite launchings under the *Orbiter* programme were scheduled for the summer or autumn of 1957.

● Latest Vanguard launching fails

The U.S. Navy made a fresh attempt on the morning of February 5th to launch a *Vanguard* rocket carrier and satellite at Cape Canaveral. At 02.33 hrs. local time the three-stage rocket slowly rose from the launching pad, accelerated at an increasing rate and appeared to climb vertically according to schedule. Then, after about 60 seconds, the vehicle began to wobble, whereupon the security officer on the ground passed the remote-control order to destroy the vehicle. The *Vanguard* broke into two and fell to the ground.

According to an official spokesman, a fault developed in the first-stage rocket motor gimbal control mechanism about one minute after launching; this resulted in a deviation from the required trajectory and necessitated destruction of the vehicle. This test launching was the second firing of a completely equipped and fully-fuelled *Vanguard* with satellite mounted: the first full attempt had already failed on December 6th, 1957, when the first stage of the rocket vehicle exploded immediately after take-off. Another fully equipped *Vanguard* is reported to be ready at Cape Canaveral and this third satellite vehicle may in fact have been launched by the time these lines appear in print. The present programme calls for the launching of two smaller satellites by means of *Vanguard* rocket vehicles before the launching of the U.S. Navy's 21½-lb. satellite scheduled for March 1958.

● The U.S.A.F.'s satellite projects

While the U.S. Army's and U.S. Navy's activities with *Explorer* and *Vanguard* have been fairly widely publicised, the U.S.A.F.'s satellite plans are, for the most part, being kept quiet. It has recently become known that the U.S.A.F. plans to bring a reconnaissance satellite into orbit within a year, using a converted *Thor* I.R.B.M. as the carrier vehicle; it is intended that this satellite will be recoverable. It has also been reported that the U.S.A.F. is planning to launch a satellite body capable of reaching the moon, using a *Thor* rocket and the second and third stages of either *Vanguard* or the Lockheed X-17 as the carrier vehicle.

At Lockheed, a reconnaissance satellite to meet the U.S.A.F.'s specification is taking shape, and has been designated WS-117L *Pied Piper*; financing and development of this project will be the responsibility of the *Advanced Research Project Agency* (*A.R.P.A.*), headed by Roy Johnson, which has recently been established by the U.S. Secretary of Defense.

● Development of a global glide bomber

According to a further report filed by *Interavia's* Washington correspondent, the U.S.A.F. budget request for the fiscal year beginning July 1st also seeks funds to develop a hypersonic glide bomber and satelloid reconnaissance vehicle for observation of the

A view of Northrop Aircraft's production plant for the SM-62 *Snark* strategic missile.

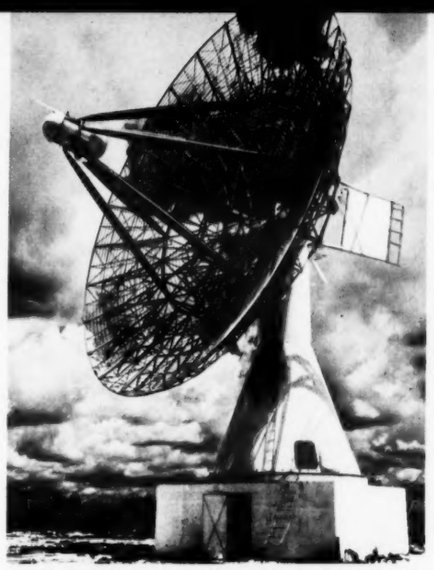
earth's surface at very high altitude. The glide bomber project calls for the development of a manned supersonic vehicle with a range of approx. 22,000 miles, which will be launched to an altitude of 280,000 ft. by means of booster rockets and, after the ending of the ballistic phase, would almost encircle the earth in a long-range glide.

Another version with a reduced payload would attain very much greater altitudes and make several circuits of the earth. If furnished with photographic equipment such a vehicle could be employed for reconnaissance work. For the first two launching stages it is proposed to utilize the Martin-developed *Titan* I.C.B.M. motors. It is proposed that the third stage (the glide-vehicle proper) would be powered by a rocket motor using very high energy liquid propellants giving a thrust of some 35,000 lb. According to a senior U.S.A.F. officer, development work on a research vehicle for the planned glide bomber will be commenced "within a few months".

According to American aviation circles, Bell Aircraft is one of the companies engaged in research on the airframe for a glide bomber. Boeing, Martin and Republic and other manufacturers have also reportedly prepared projects. Bendix, Goodyear and Minneapolis-Honeywell are also being mentioned as concerned in the development programme. N.A.C.A. has also participated.

● The X-15 experimental rocket aircraft

North American Aviation Inc. has recently proposed to the U.S.A.F. that the X-15 research rocket aircraft should be equipped with the three-barrel rocket take-off boosters which have been developed for the *Navaho* intercontinental ramjet vehicle. Though designed for a thrust of 145,000 lb., one of these boosters has attained a thrust of 470,000 lb. on the test stand. Equipped with this type of first stage the North American X-15 could very well be employed as a test vehicle for the U.S.A.F.'s glide bomber programme. As the recently developed X-15 can only be brought to an altitude of some 30,000 to 36,000 ft. by the B-36 or B-52 parent aircraft, present maximum speeds are limited to 4,000 m.p.h. with a maximum altitude a little over 100 miles.



The antenna array of the U.S.A.F.'s TLM-18 automatic target tracking radar. The TLM-18, the largest of its type, is utilized for tracking American missiles over the 5,000 mile test range from Cape Canaveral out into the South Atlantic. The reflector, manufactured by Radiation Inc. Melbourne, Fla, has an overall diameter of approx. 63 feet.

U.S.A.F. officials comment that although the X-15 has some limited capability it would require "very considerable change" to be utilized for investigation of sub-space problems related to the glide bomber project. They appear to favour an entirely new system designed from the ground up for substantially greater penetration of space.

● New high-energy propellants

In connection with the U.S.A.F.'s glide bomber project it is also reported that the United States industry is working on new high-energy propellants for rocket motors, although on a fairly modest scale at the present. For example, Bell Aircraft Corporation and North American Aviation are presently burning highly toxic and corrosive fluorine as an oxidizer. Bell has been experimenting on a test stand engine with 35,000 lb. thrust, while North American has been working with a somewhat smaller powerplant. Dr. Walter Dornberger, technical assistant to the President of Bell Aircraft Corporation, is urging that the U.S. Government give its immediate support to programmes to develop the following three combinations: fluorine-ammonia; fluorine-hydrazine; liquid hydrogen-oxygen.

● The anti-missile programme

U.S. Defense Secretary, Neil McElroy, has decided to split the anti-I.C.B.M. assignment between the Army and the Air Force; the Army has been given responsibility for the interception part of the ballistic missile defence mission, while the Air Force is left with the radar acquisition assignment. This means that Douglas Aircraft Co. Ltd. will go ahead with its programme to develop the *Nike-Zeus* counter-missile and that the *Wizard* anti-missile under development by Convair Division of General Dynamics Corp. will be dropped. The U.S.A.F.'s main contractor for the I.C.B.M. radar detection programme is the Radio Corporation of America. The *Nike-Zeus* system will require many long-range radar stations with equipment for air space surveillance, target acquisition and tracking, and these stations will be under U.S.A.F. command.

Interavia's Washington correspondent reports that McElroy's decision is taken as further evidence of his determination to remove new weapons systems development projects from the arena of inter-service rivalries. As in the case of his decision to order both the U.S.A.F.'s *Thor* and the Army's *Jupiter* I.R.B.M.s into production, the solution to the anti-I.C.B.M. problems has satisfied neither the Air Force nor its industrial suppliers. Particularly criticized is the divided command for the actual operation of the anti-I.C.B.M., and this will call for closer integration of the Army Air Defense Command and the U.S.A.F. Air Defense Command.

● Fifth Atlas I.C.B.M. test launching

A fifth Convair *Atlas* I.C.B.M. was launched at the Missile Test Center, Cape Canaveral on February 7th. After an apparently satisfactory vertical launching the vehicle began to put out a white smoke trail before disappearing from view. A U.S.A.F. spokesman said later that the vehicle had destroyed itself, but gave no more precise information. The cause is generally believed to have been an explosion of the residual propellant.

At the Culver City plant the Douglas Aircraft Company has set up a *Jupiter* I.R.B.M. demonstration launching site, displaying all the equipment necessary for the preparation of the launching. Illustrated left (from left to right) are: mobile generating sets and air conditioning trailers, hydraulic powerplants, etc. (foreground), oxygen containers and pressurized gas containers for feeding the liquid oxygen, the launching control centre, a launching ramp with a *Thor* I.R.B.M., additional pressurized gas containers for feeding the fuel, fuel containers, etc.

Situation Report from Bonn

Federal Defence Minister Strauss with Lieutenant General Röttinger, Inspector of the Army, during the autumn manoeuvres.

The Hardt Hills above Bonn, headquarters of the Military Sections (including the Air Force) and the Technical Section.

Hotel Königshof, Bonn, headquarters of the "assault force" against the Federal Defence Ministry, i. e., the arms sales teams from throughout the world.

This once so quiet, secluded little university town on the banks of the Rhine today presents quite a different picture. No longer is the scene dominated by the students' caps and regalia of the Kaisers' Germany, or by princesses, generals or civil servants living in retirement. Parallel to the Rhine bank, between Bad Godesberg—today the residence of the more well-to-do Bonn citizens—and the West German capital runs the Koblenzer Strasse with the new ministries.

On the left is the Palais Schaumburg, formerly the residence of a sister of Kaiser Wilhelm II, where the Federal Chancellor today holds sway. It is flanked on the one side by the Foreign Ministry's imposing new buildings, and on the other by a brand new stone block, headquarters of the Federal Press Office and Under-Secretary of State von Eckardt. A Bonn story has it that the "Old Man"—as the Chancellor is popularly known—disturbed by the appearance of the utilitarian Press Office, had called the head gardener and instructed him to plant trees to improve the view. The gardener had recommended poplars, as these would grow fastest, but cautiously remarked that it would be ten years before the desired result was achieved. The 82-year-old Chancellor smiled . . . and told him to go ahead.

*

The most striking building where the Koblenzer Strasse runs into the town centre is the rebuilt Königshof, Bonn's leading hotel. The lobby and restaurant teem with visitors from all parts of the world, but English is the dominant language. The hotel rooms are somewhat austerely furnished, though they do look on to the Rhine. Yet there are seldom vacancies. Since the beginning of 1958 the hotel has housed the "assault force" which the world's arms industries have let loose on the Ermekeil Barracks (headquarters of the Federal Defence Ministry), the Hardt Hills above the town (Air Force headquarters) or the Central Technical and Procurement Office in Koblenz. The number of these hotel guests is impressive. A visitor during the second half of January could distinguish among the cheerful crowd the sales staffs of half a dozen aircraft manufacturers from Britain, the United States, France or Sweden. The weather in Bonn was bad, and it was certainly not the Rhine terraces or the vine-yards which had attracted these particular visitors.

*

The man who is at any rate indirectly the centre of interest for the sales teams sits enthroned in an old red brick building, the Ermekeil Barracks—though "enthroned" is perhaps not the right word. The Federal Defence Ministry bears no resemblance to the once so imposing Reich Air Ministry or to Washington's Pentagon, and not much to the defence ministries of other countries. A sentry at the entrance, then the reception office on the ground floor, a glassed-in compartment for visitors waiting to see the Minister—and then you find yourself in his very modestly furnished anteroom. The Minister's own office is as he took it over from his predecessor: it contains a large desk and upholstered seats in one corner for visitors.

Dr. Franz Joseph Strauss gives the impression of being a physically and mentally powerful man, with whom it would be unwise to cross swords. But provided you do not come to him with "immoral propositions"—i. e., the desire to favour his Ministry with weapons of any kind—you will find him frank and natural in conversation. This Bavarian son of the people and expert on ancient languages proves to be a cultured, open-minded man.

*

The German armed forces, which have been under his care for more than a year, have now been more or less safely delivered into the world, though—like all infants—they still have their teething troubles to face.

By 1961 Strauss must create a *Bundeswehr* of some 250,000 men, of which roughly 140,000 were already under arms in January 1958. Officers and men have got to know each other, full equipment is progressively becoming available, and training is becoming more thorough as experience grows.

The Minister has also succeeded in smoothing out some of the rivalries between officers and civil servants. It may be that not all the responsible staff which he took over from the Theodor Blank era are the men he himself would have chosen. But Strauss has an unerring diplomatic sense in the definition of responsibilities.

One difficulty which is now beginning to emerge in constituting West Germany's armed forces is the shortage of personnel, especially in the technical field. Good men are already settled in industry and are not likely to be tempted by Government pay scales. Whereas in the "founding years" there was a dearth of more or less well-

Federal Defence Minister
Dr. h. c. Franz Joseph Strauss

Under-Secretary of State
Dr. Joseph Rust

General Heusinger, Inspector General
of the German armed forces

General Joseph Kammhuber,
Inspector of the Air Force

Training on Lockheed T-33s at Fürstenfeldbruck.

The Army's Bell 47 helicopter.

paid, Parliament-approved posts in the Defence Ministry, today there are not enough people to fill the posts available. The only hope lies with the rising generation.

Another snag for the Minister is the fact that he cannot touch large portions of his defence budget without specific authorization from the Finance Minister. As a result tough battles must often be fought in Parliament before important armament plans can be put into effect.

*

Now for the *Air Force*.

To the external observer, its development seems to be going on quietly, mainly at the training centres in Germany and abroad. The first fighter, fighter-bomber and reconnaissance squadrons have yet to be formed.

The most urgent tasks continue to be training itself, and the provision of air bases and accommodation, both of which are still inadequate. Supply bases for equipment have already been established, but need expansion.

And the aircraft industry, which exists more on paper than in fact, is taking its first hesitating steps with modest initial contracts. This situation is unrealistic. Time is running out—the Air Force must be a reality by 1961!

What is to be done? What aircraft are to replace the foreign equipment so far acquired and now being used more or less only for training purposes? What are the prospects of follow-on contracts for an aircraft industry which Strauss may have succeeded in resurrecting by that time? All that can be said with certainty at the moment is that no production "flying weapon system" can be expected to emerge from the German industry within the three years available. Hence equipment must again be bought from abroad . . . and hence the offensive being directed at the Ermekeil Barracks and the Hardt Hills from the Hotel Königshof! The Defence Minister and his Air Force chief General Kammhuber face difficult decisions.

The latter went to the United States with a small delegation early in February for another look at American aircraft. Other missions are going to France and Sweden, and perhaps England. At the moment of writing it seems not impossible that the dice may ultimately fall in favour of the Lockheed F-104A all-weather fighter, while the light strike fighter selected may perhaps be a development of the Fiat G. 91. And early in March Minister Strauss and Lieutenant General Kammhuber will meet again in Washington, perhaps to make an on-the-spot decision.

*

Meanwhile two topics which have been under discussion for years have again arisen: *aeronautical research and aircraft industry*.

Without research there can be no modern industry. At the end of January the Federal Cabinet received the draft of a decree making Federal funds available for aeronautical research on a broader basis, to bolster the modest funds provided by the individual Land Governments.

It is some years since Professor Leo Brandt, Under-Secretary of State in North Rhine-Westphalia, managed to get approval for the first credits to reactivate the *Deutsche Versuchsanstalt für Luftfahrt* and the *Wissenschaftliche Gesellschaft für Luftfahrt*, but the resources of a single Land Government could never suffice in themselves. Scientists and engineers have rallied round, but the personnel employed in these research establishments live from hand to mouth, and there is a growing tendency for them to move away to more secure positions in industry or abroad. Faced with this depressing situation, the Defence Minister sent an S.O.S. to the Cabinet, and it looks as if—leaving aside details of the plan for the moment—the proposed draft may be approved unanimously.

The question remains, however, of whether this first step is to be followed by the logical second step. So far, apart from small orders rather in the nature of charity, the Federal Government—the only possible customer for the aircraft industry—has not awarded any real contract for independent development. At the moment the enthusiasm of the "old guard" of aircraft designers has been aroused by visions of an "ideal all-weather fighter", which have led them to form a joint working group. It is rumoured that this group of hopeful but relatively impecunious manufacturers may be joined by a large enterprise, the Daimler-Benz engine concern. Reportedly there is serious talk of a merger between the financially strong Daimler-Benz firm, of Stuttgart-Untertürkheim, and the financially less favoured Bayrische Motorenwerke, of Munich. Maybe... As Frederick B. Rentschler, founder of Pratt & Whitney, once said, the powerplant is the heart of any aircraft.

German tanks during the autumn manoeuvres.

A German Navy mine-sweeper squadron.

In any case there is no doubt that the Defence Ministry is decided to give a German aircraft industry a chance, though the Federal Aircraft Manufacturers Association has not so far produced anything very sensational in the way of results. Beginnings of real industrial activity are to be seen only in one field, namely that of electronics, where Telefunken is all set to go.

*

All this had to be outlined briefly in order to explain the objects of the arms development pool recently established between France, Italy and Germany. Strauss is a man of the West, and hence no partisan of misguided autarchy. As Minister for Atomic Affairs he was a good customer of the United States and British industries. As Federal Defence Minister he is beginning to take his place in international politics. Fundamentally he is also doubtless a good European, and it is quite on the cards that he does not wish to enter into a European pool with empty hands, but to bring a German industrial contribution with him.

EEH

Reorganization of the Federal Defence Ministry

Early in January 1958 the Federal Defence Ministry Departments and the Command Staffs of the German armed forces were reorganized on the following plan:

Department VR	(Verwaltung und Recht = Legal and Administrative)
	— Ministerial Director Wirmer
Department U	(Unterkunft und Liegenschaften = Barracks and Real Estate)
	— Ministerial Director Schiffers
Department H	(Haushalt = Budget)
	— Ministerial Director Hopf
Department W	(Wirtschaft = Economy)
	— Ministerial Director Dr. Holtz
Department T	(Wehrtechnik = Technical)
	— Ministerial Director Dipl.-Ing. Vorwald
Command Staff of the Armed Forces	
	— General Heusinger
Command Staff of the Army	
	— Lieutenant General Röttinger
Command Staff of the Air Force	
	— Lieutenant General Kammhuber
Command Staff of the Navy	
	— Vice Admiral Ruge
Inspector of the Medical Corps	
	— Surgeon General Dr. Joedecke

The *Central Technical and Procurement Office* ceases to be part of the Defence Ministry and replaces the old Koblenz Procurement Office. Engineer General Heinrich Sellschopp has taken over control of the Air Force Equipment section of the Central Office.

What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

Aero O/Y (Finnair) has ordered three SE.210 *Caravelle* medium-range jet airliners from Sud-Aviation. They will be delivered in February, March and April 1960. Left, S. J. Ahola, President of the Finnair Board; right, Georges Héreil, President and Managing Director of Sud-Aviation.

Frank N. Piasecki (standing), President of Piasecki Aircraft Corporation, and Henri Ziegler, Managing Director of Ateliers d'Aviation Louis Breguet, signed a technical interchange agreement for their respective companies on January 15th, 1958. It is interesting to note that this is the first such contract between private French and American companies.

AIR TRANSPORTATION

● **The U.S. Civil Aeronautics Board** has approved an interim average 6.6 percent rise in domestic air fares. The new fares are to remain effective until the C.A.B.'s General Passenger Fare Investigation is completed in a few months time. The new fares will be based on a straight 4 percent increase over existing fares, plus an extra $ 1 charge on each ticket. The C.A.B. decision was reached by a three-to-two vote, with Chairman James R. Durfee, and members Harmar D. Denny and Louis J. Hector in favour; Vice Chairman Chan Gurney and member G. Joseph Minetti were against.

● **Capital Airlines** has placed an order with Convair Division of General Dynamics Corporation for fifteen Convair 880 jet airliners. According to Capital President David H. Backer, General Dynamics will finance the purchase of the fifteen aircraft at an aggregate price of $ 60,000,000 (including spare parts). In addition, General Dynamics has agreed to refinance the $ 48,512,000 that Capital still owes on its sixty Vickers *Viscounts*. Details of the financial arrangements have not yet been revealed.

● **New York Airways** has decided to purchase a new $ 2,000,000 fleet of five fifteen-passenger Vertol 44-B giant helicopters, the first of which will be delivered in April. Three more will be delivered in May, and the last in June. The company earlier announced that it would dispose of its three Sikorsky S-58s and five S-55s.

● **A network of feeder services** operated by private companies to connect the outlying districts of South Africa to the domestic air routes of South African Airways is being planned. Four and five-passenger aircraft are to be used on routes linking the Northern Transvaal with Johannesburg and Kimberley, and the Karroo with Bloemfontein, Port Elizabeth and Cape Town. There are already "bush" services connecting Zululand with Durban, Transkei with Durban and East London (Natal Aviation) and the Free State Goldfields with Johannesburg and Durban (Commercial Air Services).

The plan is being pushed by the Associated Chambers of Commerce of South Africa and the Commercial Aviation Association. Negotiations are under way with the Railways, Harbours and Airways Administration and organized commerce plans to put its case to the Civil Aviation Advisory Committee, which advises the Minister of Transport. Business interests are urging duty free aviation fuel to local operators (international operators already get it duty free) and more generous mail contracts.

● **Transcontinental S.A.**, Argentina's private enterprise airline, will inaugurate services between Buenos Aires and New York in April; intermediate stops on the route will be Sao Paulo, Rio de Janeiro and Caracas. The flights will be made with three 88-passenger Lockheed 1049H *Super Constellations*. The initial frequency will be three flights a week, to be stepped up later to five a week. Transcontinental, established in 1956, plans at a later date to extend its services to Japan—via Lima, Bogotá and San Francisco.

● **Aerlinte Eireann Teoranta,** sister company to Aer Lingus, has announced plans to start its own triweekly economy class service between Dublin and New York in April. The aircraft used will be three Lockheed 1049H *Super Constellations* leased from Seaboard and Western Airlines. This will be the second attempt by Ireland to get into the Transatlantic business. Earlier plans in 1948 were scrapped following a change of Government, and five specially bought *Constellations* were re-sold.

● **The B.O.A.C. Britannia** 102 was first introduced into service a year ago on February 1st, 1957, on the route between London and Johannesburg. During this period, the *Britannias* have carried nearly 77,500 passengers and have flown some eight million miles during 28,000 hours on revenue earning services. All but 100 of the total hours have been recorded by the Corporation's fleet of fifteen medium-range *Britannia 102s*, the long-range *Britannia 312* having only recently begun operations on the North Atlantic. The *Britannia's* average revenue passenger load factor was 72 percent, and each aircraft is now flying on an average nearly eight hours per day. This utilization is very similar to that of the DC-7C aircraft introduced into service by B.O.A.C. at the beginning of 1957 and better than that of any other aircraft type in its first year of B.O.A.C. service. The *Proteus 705* engine fitted to the *Britannia 102* is now certified to run 1,050 hours between overhauls and is expected to be certified for 1,300 shortly.

● **Swissair** in January put into operation an I.B.M. 650 electronic computer which is being used to compile traffic statistics, prepare invoices for freight and salary sheets. Eventually it is planned to use the computer also for calculating procurement costings. The installation is the biggest of its kind in Switzerland. The computer was supplied by the I.B.M. works at Sindelfingen, the annual rental paid by Swissair being 400,000 Swiss francs.

● **An increase in landing fees** is contemplated by the German Airport Association (Arbeitsgemeinschaft Deutscher Verkehrsflughäfen). According to a statement made by Walter Luz, Manager of Frankfurt Airport, at the general meeting of Flughafen-Aktiengesellschaft, landing fees in Germany—based on a tariff of DM 4.— per tonne—are lower than average. The aim is to find a happy medium between the current charges and those imposed in other countries.

This twin-engine light transport and communications aircraft has been developed by Fábrica Militar de Aviones, Córdoba. Designated I.A.45, it is fitted with two 150 h.p. Lycoming engines and has cabin space for five persons.

Peter Twiss, Fairey's chief test pilot, has completed a helicopter conversion course at Air Service Training Ltd., Hamble. Here he is seen at the controls of a Hiller 12.C. Standing is Squadron Leader George Webb, AST's Chief Flying Instructor.

Assembly of the first production model of the F.27 *Friendship* at the Fokker factories in Schiphol (left). During a demonstration tour to India and the Middle East a Fokker F.27 *Friendship* landed on the airfield at Leh, Kashmir, which is situated at 11,544 ft. altitude. It was the first transport aircraft to do this. At an all-up weight of 34,320 lb., no wind and a temperature of minus 35°F, the *Friendship* needed only 840 yards. Foothills of the Himalaya mountain range can be seen in the background.

● **Cologne-Wahn Airport** is to become the German Federal Republic's second jet airport. Appropriations amounting to DM 2,000,000 are envisaged for the airport in the national budget for 1958. This sum includes DM 500,000 in current subsidies and DM 1,500,000 as a first installment towards the development project. A bid by Düsseldorf to be chosen instead of Cologne was turned down. According to the D.P.A. news agency, the Federal Ministry of Transport found that Düsseldorf Airport was unsuitable for development because of difficulties in providing adequate air traffic control. It is also reported that the Mayor of Hamburg has suggested to the Transport Ministry's Air Transport Advisory Council that Fuhlsbüttel Airport be transformed into a jet airport for North Germany capable of handling intercontinental traffic.

INDUSTRY AND RESEARCH

● **Boeing Airplane Co.** is working on two new defensive missile projects. Lysle A. Wood, Boeing Vice President and General Manager of the company's Pilotless Aircraft Division, said that both of the new projects are defensive weapons systems: an advanced model of the *Bomarc* with a solid propellant motor, and an anti-ballistic missile system. The development of the *Bomarc* is already well advanced. Identical in external appearance to the present *Bomarc*, the new missile will fly as a pilotless interceptor and be armed with a nuclear warhead, but will have substantially more range. Object of the anti-I.C.B.M. weapons programme is the development of a weapon system capable of detecting, intercepting and destroying I.C.B.M.s "so far above the earth that atomic fallout would not be a problem". For security reasons, no details were given.

● **Boeing Airplane Co.** has taken two steps in order to speed up technical research and development work: 1. Establishment of a new research organization to be known as the Boeing Scientific Research Laboratories. The organization will function in the field of basic research, and George S. Schairer, Boeing Director of Research, will serve as Acting Director pending appointment of a Scientific Director who will report to Schairer. 2. Wellwood E. Beall, Senior Vice President, with the assistance of Edward C. Wells, Vice President Engineering, has been assigned responsibility for leading the company's overall programme of advanced developmental work. To relieve Beall of most of his present administrative duties, C. B. Gracey has been appointed Vice President Operations, reporting to Beall. George C. Martin, who will also be made a Vice President, will succeed Gracey as General Manager, Seattle Division. H. W. Withington, formerly a senior project engineer, has been named Chief Engineer of the Seattle Division.

● **Lockheed Aircraft Corporation** has received a new $ 11,400,000 U.S. Air Force order for T-33 jet trainers. Bringing scheduled production to a total of more than 5,600 aircraft, worth over $ 500,000,000, the new contract marks the 15th successive re-order for the two-seat trainer by the military services. It will extend production into late 1959.

● **An exclusive licence agreement** has been signed by Lockheed Aircraft Service, Inc., Ontario, Calif. and the Mechanical Division of General Mills, Inc., Minneapolis, Minn. for L.A.S. to manufacture and sell G.M.I. flight recorders. The equipment will be required by the Civil Aeronautics Administration on all large aircraft used in air transportation above 25,000 ft. after July 15th, 1958.

● **The U.S. Senate** has approved overwhelmingly a $ 1,260,000,000 defence expenditure bill to speed up missile programmes and dispersal of the Strategic Air Command's big jet bombers. The Bill, introduced on the opening day of Congress, also makes available funds for a third intercontinental missile base, a missile detection system and three atomic submarines to fire the Navy's new *Polaris* missile. A censored transcript released by the Senate Appropriations Committee disclosed that Defense Secretary Neil H. McElroy rejected a suggestion by Senator Stuart Symington of the Armed Services Committee that the Bill be increased to $ 2,600,000,000 to build more B-52 bombers and push the missile programme even faster.

● **Aircraft Manufacturing Company Ltd. (Airco)** will be the name of the company which de Havilland, Hunting and Fairey have arranged to form to work on the DH.121 jet airliner.

The Nord-Aviation *Griffon 02* combination pure jet and ramjet fighter has achieved a speed corresponding to Mach 1.85 in a climb at 19,680 f.p.m. The *Griffon 02* is fitted with one SNECMA-Atar 101 E.3 turbojet with a thrust of 7,720 lb. combined with a Nord-Aviation ramjet. (A detailed article on the *Griffon 02* will be published in *Interavia Review* No. 4, 1958). Right, Japan's Fuji T1F2 two-seat jet trainer.

The Italian Aer Lualdi L. 55 helicopter, flight testing of which began on January 25th, 1958. Manufactured by Aer Lualdi & C., Udine, the L. 55 is fitted with a 180 h.p. Lycoming engine and, with a payload of 990 lb., has a normal cruising speed of 73 knots; service ceiling is 12,795 ft.

Second prototype of the Breguet *Taon* light strike fighter (Br. 1001-02) which was first flight tested on January 18th.

● **Elliott Brothers (London) Limited** who had a special department for the general sales and servicing of American-made Bendix aviation and radio equipment, have discontinued this department. They will concentrate on the manufacture under licence of the wide range of Bendix-designed equiqment and on the sale and servicing thereof.

● **Laboratori Elettronici Riuniti (L.E.R.)** has been founded in Rome with a capital of 60,000,000 lire for the purpose of conducting research into the applications of electronics. The Chairman of the Board is Ermanno Guani, Managing Director of Società Finanziaria Meccanica (Finmeccanica) which controls all the engineering firms whose capital is owned by the State. Manager of L.E.R. is Massimo Macchia, an electronics expert. The business address of the new company is Via Pasquale Stanislao Mancini 27, Rome. L.E.R. is an associate of Microlambda and Nuova San Giorgio which are also controlled by Finmeccanica, and of Officine Galileo. According to reports from Rome, it is rumoured in the Italian capital that L.E.R. will concentrate mainly on research on missiles and fire control systems.

AIRCRAFT AND POWERPLANT

● *Générale Aéronautique Marcel Dassault* is developing a new 8-seat twin-jet executive aircraft known as the Dassault *Méditerranée*. It will have swept-back wings and tailplane. The two *Farandole* jet engines, which were developed by Dassault itself, are mounted in nacelles beneath the wing; each has a thrust of 3,087 lb. The *Méditerranée* is reportedly designed for a cruising speed of 485 knots and a range of 1,350 nautical miles.

● Type certification tests of the *CASA-207 Azor* passenger transport have now been completed. The flight testing programme was carried out by the Instituto Nacional de Técnica Aeronáutica "Esteban Terradas" (I.N.T.A.) using I.C.A.O. standards.

● *Aero Design and Engineering* is carrying out work on a V.T.O.L. aircraft in conjunction with N.A.C.A. The aircraft under test is basically an *Aero Commander*, retaining its two piston engines, but utilizing large-area flaps to deflect the propeller slipstream. Turboprops will reportedly be utilized later.

● A twin-jet 8-seat executive aircraft, designated the *Triphibian A-1*, is being developed by the *Air Craft Marine Engineering Co.*, Van Nuys, California. The A-1 will provisionally be powered by two Continental 420 jet engines, and is to be fitted with a boundary layer control device to achieve short take-off and landing characteristics.

● Latest details of the *Grumman Gulfstream*, powered by two Rolls-Royce *Darts*, now reported are: range 1,180 n.m. plus a reserve for 110 n.m.; cruising speed 320 knots at 25,000 ft.; operation from airfields with runways less than 4,000 ft. Span 78 ft. 6 in.; length 64 ft.; gross weight 31,000 lb.

● For the *Bell 47G* and *47G-2* helicopters an increase in the authorized life between major overhauls to 1,200 hours has been approved by C.A.A.

● *North American* has commenced assembly of the *UTX jet trainer*. This aircraft is a so-called "combat readiness trainer".

● A *Pratt & Whitney J75-P-5* with afterburner will power the new F8U-3 version of the Chance Vought *Crusader* naval fighter. The first flight of the F8U-3 is planned for the summer of 1958, and delivery to the U.S. Navy is promised for 1960.

● The *General Electric CJ-805* jet engine has completed its civilian acceptance trials using JP-4 fuel; the CJ-805 will power the Convair 880. A second engine will carry out a further series of trials using kerosene.

● Engineer Filippo Zappata, head of the design office at *Costruzioni Aeronautiche Giovanni Agusta*, is working on the design of a new helicopter which, apart from the incorporation of the Bell rotor, will be independent of Agusta's licence agreement with Bell. In addition to the Agusta X-1 the company plans to produce the following types: Agusta 101, equipped with three turbine engines, with seating for a crew of three and sixteen passengers; it is also intended for anti-submarine tasks; Agusta 102, 7-seat helicopter powered by a Pratt & Whitney engine.

● First flight of the *Piaggio P.166*, powered by two 340 h.p. Lycoming GSO-480s, has taken place at Albenga.

● **The supersonic Convair B-58 Hustler** is armed with a *Vulcan* fully automatic cannon firing 7,000 rounds per minute, the U.S.A.F. announces. The cannon, mounted in the rear fuselage, is remote-controlled and has six barrels clustered in a drum. Development of the weapon was begun some years ago under contract to the U.S. Army Ordnance and later handed over to General Electric Company. The six barrels are arranged symmetrically inside the drum in such a way to prevent double loading. Only one barrel can be fired at a time, which eliminates the erratic recoil of multiple installations. Duds are automatically eliminated and cannot cause blockages.

Loading of a Folland *Gnat Mk. 1* for the Indian Air Force into an I.A.F. Fairchild *Packet*, at Folland's Chilbolton aerodrome.

The cabin of a full-scale mockup of the Convair 880 jet airliner.

Two years service with the Royal Air Force has established the Jet Provost ab initio/basic trainer as the best aircraft for its purpose, and the Mk3 powered by one Armstrong Siddeley Viper Turbo-Jet is now in production for the re-equipment of Flying Training Command.

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Book Reviews

Jane's All The World's Aircraft 1957-1958. Compiled and edited by Leonard Bridgman, assistant compiler John W. R. Taylor. Published by Sampson Low, Marston & Co. Ltd., London, 1957. (English, 488 pages, 105 s.)

Can there be anyone in the field of aviation who does not already know and respect this authentic and painstaking work ? In its 48th year of issue this old friend is as impeccably correct as ever, and as complete as security restrictions permit. Slightly larger than the last edition, the text has been completely revised and there are some 590 new illustrations to delight the enthusiast and the professional man.

As in previous years the exhaustive indices are followed by sections covering: Military Aviation, Civil Aviation, Civil Airline Operators, Aircraft, Engines and—often overlooked in this jet age—Airships. The general index of aircraft alone occupies 14 pages and gives reference to every type manufactured over the last 10 years. The Aircraft Section is now 339 pages strong, with a total of 721 illustrations, including 14 pages on Russia. Also included in the Civil Aviation Section are details of the organization and work of such bodies as the International Civil Aviation Organization (I.C.A.O.), the International Air Transport Association (I.A.T.A.) and the Fédération Aéronautique Internationale (F.A.I.), together with a table showing the title, main address, fleet strength, route mileage, miles flown, passengers and freight carried in 1956 for a total of 297 carriers, listed by countries.

In his preface to this edition, Mr. Bridgman promises a self-contained Guided Missiles Section in the future and, in view of the developments in this field over the last few months, it is to be hoped that this will appear in the 1958-1959 edition.

Ru.

Electronic Engineer's Reference Book. General Editor L. E. C. Hughes. Published by Heywood & Co. Ltd., London, 1958. (English, 1312 pages. 84 shillings.)

Faced with the mass of technical and scientific data circulated today, no ordinary man can be expected to fully digest, let alone remember, all the facts in his associated fields. This reference book presents junior industrial and development engineers with some of the latest knowledge and techniques in the chemical, production, safety, reliability and maintenance aspects of his work, in a readily available and handy form. The work contains a wide range of useful information following the origin of various effects under the general definition of "electronics", to their practical realization, utilization and integration in industry.

After a brief history of electronics the work is divided into nine sections covering: Fundamentals, Radiations, Electrics, Valves, Materials, Vibrations, Computers, Automatics and a Miscellaneous chapter; over fifty experts and specialists have contributed articles on the particular fields in which they are active.

It will definitely not fit your hip pocket, but should find a permanent place on many desks.

Ru.

Automatisierung. Stand und Auswirkungen in der Bundesrepublik Deutschland. Edited by the Rationalisierungs-Kuratorium der Deutschen Wirtschaft RKW. Published by Hanser Verlag, Munich, 1957. (German, 259 pages. 427 illustrations. DM.22.)

Some two hundred firms who have either adopted a large degree of automation in their plants, or who themselves produce installations and equipment for automation, have provided the material for this report. The work discusses the economic, professional and social effects of automation and carries detailed and well-illustrated examples of application and proposals for almost every branch of industry and administration. The book offers a wealth of practical information which can be of great value to both management and technical staffs in the solution of their special problems.

Na.

50 Jahre Werkzeugmaschinenfabrik Oerlikon. Compiled and issued by Oerlikon Machine Tool Works, Bührle & Co., Zürich, 1957. (German, 209 pages.)

In this age of huge, impersonal industrial concerns, the present-day executive boards rarely show any remaining trace of the original founders; it is therefore interesting to read the history of at least one enterprise where, in spite of its world-wide activities, the responsibility still rests on one pair of shoulders. Today Oerlikon-Bührle employs some 8,000 people and has the most widely ranging industrial interests, but the whole development and current activities of the firm clearly reflect the personality of the founder, Emil Georg Bührle. Following the latter's death in 1956 the executive responsibility today rests on the shoulders of Dr. Dieter Bührle, the founder's son. The present excellently produced and widely illustrated book clearly underlines the extent of Oerlikon-Bührle's activities in the Aircraft and Missiles Industry: Oerlikon anti-aircraft rockets and cannon; in the field of electronics the subsidiary Contraves AG; and the Pilatus aircraft works subsidiary company.

He.

Elsevier's Dictionary of Television, Radar and Antennas (in six languages). Compiled and arranged on an English alphabetical base by W. E. Clason. Elsevier Publishing Company, Amsterdam/Houston/London/New York, 1955. Distribution for English-speaking areas: Elsevier Press, Houston, Texas and New York (for U.S.A. and Canada); Cleaver-Hume Press, London (for the British Commonwealth). For French language areas: Dunod, Editeur, Paris. For German: R. Oldenbourg Verlag, Munich. For Italian: Libreria Sansoni, Florence. For Spanish: Editorial Labor, Barcelona. For all others: Elsevier Publishing Company, Amsterdam. (English/American - French - Spanish - Italian - Dutch - German; 760 pages.)

Elsevier's Dictionary of Electronics and Waveguides (in six languages). Compiled and arranged on an English alphabetical base by W. E. Clason. Elsevier Publishing Company, Amsterdam/Houston/London/New York, 1957. Distribution for English language areas: D. van Nostrand Company Inc., Princeton, New York and Toronto (for U.S.A. and Canada); Cleaver-Hume Press, London (for the British Commonwealth). For French language: Dunod, Editeur, Paris. For German: R. Oldenbourg Verlag, Munich. For Italian: Libreria Sansoni, Florence. For all others: Elsevier Publishing Company, Amsterdam. (English/American-French-Spanish-Italian-Dutch-German; 628 pages.)

To keep pace with the increasingly international character of scientific knowledge, and the associated demand for multi-language interpretation, Elsevier has published a series of technical dictionaries covering various fields of science and industry. In planning the volumes the compiler, who is head of the translation department of N. V. Philips Electrical Works, Eindhoven, Holland, has followed principles suggested by UNESCO. The basic word list is English, with American and British usages clearly distinguished, and definitions in English are included for each subject. The other languages have their own word lists, numerically keyed to the English.

Interavia's four-language Editorial Staffs can bear witness to the great usefulness of these works.

Na.

Books Received

Reports of the Deutsche Versuchsanstalt für Luftfahrt e.V.; issued by the Zentrale für Wissenschaftliche Berichtswesen der DVL, Mülheim, Ruhr ; published by Westdeutscher Verlag, Cologne and Opladen, 1957 :

Report No. 26: *Untersuchungen über künstliche und natürliche Alterung unlegierter Mineralschmieröle*, by G. Spengler and H. O. Hössl (Price DM 16.80).

Report No. 38: *Untersuchungen über sprunghafte Peilungen an Mittelwellen-Vierkursfunkfeuern*, by H. J. Zetzmann, R. A. Wendlinger and H. Zauscher (Price DM 14.30).

Report No. 43: *Hitzdrahtmessungen in einer aufgespaltenen Kármánschen Wirbelstrasse*, by O. Wehrmann (Price DM 10.90).

Report No. 44: *Versuche an einem fertigungsgünstigen Mehrstossdiffusor bei Überschallgeschwindigkeit*, by W. Trommsdorff (Price DM 13.80).

Report No. 45: *Zur Pathogenese und Prophylaxe der Druckfallkrankheit des Höhenfliegers, Part I : Über den Einfluss der Hyaluronidase auf die Dauer der Sauerstoff-Voratmung*, by O. Wünsche (Price DM 7.00).

Man Under Pressure

By Ruth and Thomas Turner, New York City.

To quote General Thomas F. Power, Chief of the U.S.A.F.'s Strategic Air Command *—" The old mandate to ' take the high ground ' is as vital to the Air Force as it ever was to the rifle-bearing soldier ".

Manned flight outside the earth's protective blanket is today dramatically nearing reality; interceptors and bombers are already operating at altitudes where atmospheric pressure is as low as one pound per square inch, and man is compelled to rely on artificial environments, such as the pressure cabin and the pressure suit, to protect his vulnerable body. The protective devices coming into use today are basically the same as those which will be used at the greater heights where manned satellites will orbit, and the pressurized environment of short time space vehicles may differ little in principle from the environment of today's aircraft such as the F-104 or the X-15.

The pressure cabin's basic function is to simulate the conditions of the lower atmosphere but it has the disadvantage of vulnerability, and it is necessary to utilize the pressure suit as a safety device in the event of high altitude decompression. Decompression arises from a major puncturing of the pressurized area for which the pressure system is unable to compensate. Small holes, e.g. 20-mm cannon shell, are not catastrophic thanks to the recent innovation of the fail safe structure, and the mission may not be aborted; but a larger hole, for example from a rocket fragment, would be fatal to the pilot or crew members and at this point the pressure suit comes into its own.

Basically a second pressure cabin tailored to fit the body, the pressure suit gives the wearer the confidence that the parachute gave to the first experimental test pilots. When the cabin of a vehicle fails at high altitudes the internal pressure instantly drops to the " ambient " or external pressure; this is known as explosive decompression. The drop in the pressure acting on the pilot's body is immediately sensed, and the suit is inflated. This transition takes place so rapidly that no ill effects result, apart from a certain immobility caused by the rigidity of the suit material.

The two basic types of suit in use today, " full pressure " and " partial pressure ", have the same primary function of simulating air pressure on the body, and differ only in their methods. In the full pressure suit there is a gap between the suit and the wearer's skin which permits free circulation of air and also assists ventilation; because of this gap the full pressure suit is larger than the partial pressure suit. An example of this type of suit is that made by the Goodrich Company of Ohio, under contract to the United States Navy, illustration *C* below; an important feature is the glass-fronted helmet which has a rotating bearing permitting the pilot to turn his head at will. The personal oxygen supply carried by the pilot is used to pressurize the suit in an emergency and, in the event of ejection, is sufficient to maintain the pressure down to safe altitudes.

By comparison the partial pressure suit, illustrated at *B* below, is adjusted skin-tight to the wearer. Rubber capstan tubes run down the wearer's arms, legs and body, and upon cabin pressure failure pressurized oxygen is fed into these tubes. On inflation the skin-tight material is pulled even tighter, simulating the effect of higher pressures acting uniformly over the body. The MC4 partial pressure suit (Fig. *B*) which was worn by Major Simons, U.S.A.F., for a period of 32 hours during his 100,000 ft. balloon ascent last August, is the product of much experience and creative thinking on the part of those physicians, pilots, physiologists and engineers who developed it.

The third suit, *A* in the illustration herewith, although resembling a partial pressure suit, is in fact a full pressure device. It is light in weight and, complete with the oxygen backpack, weighs only 24 lb. The outer covering is metallic to reduce heat penetration and the suit has been tested at temperatures of 170°F (77°C) and under extreme cold conditions. Designed by the human factors group of North American Aviation, under the supervision of Scott Crossfield, pilot of the X-15, the boots and gloves are fully pressurized, and the helmet has excellent vision characteristics.

Although all suits have undergone environmental testing, relatively speaking the art is still in its infancy. Pictured above is another full pressure suit which is as yet not strictly operational, but which has been tested to a simulated altitude of 95 miles. This suit served the purpose of proving that man can live and work at altitudes beyond the atmosphere and under artificial conditions, with little or no discomfort.

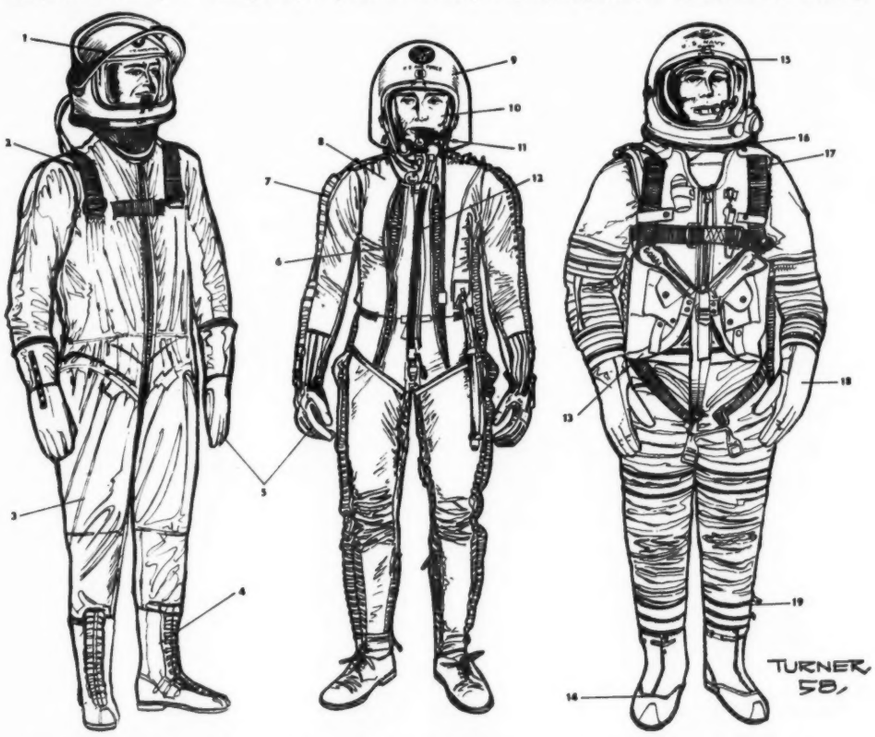
From available information it appears that Russia is also active in this field of human engineering, and the Soviet Air Force may already be equipped with pressure suits; versions of both full and partial pressure types are under test in the U.S.S.R. The main differences between the Russian and U.S. suits appear to be in helmet design and the dressing times; the Russian helmet is not removable but hinges back like the armed vizor of a bygone knight and, in view of the omission of zip fasteners, it appears that the wearer requires a complete " lace job " which could seriously delay combat readiness.

Only four years ago, men were fighting each other in the skies of Asia at heights of 50,000 feet without pressure suits. It is doubtful whether this situation will again arise now that such safety devices are available. The space suit is one of man's keys to the universe.

An experimental pressure suit which has been tested to a simulated altitude of 95 miles.

* To members of the Institute of the Aeronautical Sciences, Calif., in 1957.

Key to details : 1 - easy open/close vizor ; 2 - integrated harness ; 3 - metallic cloth ; 4 - pressurized " boxer " type boots ; 5 - pressure gloves ; 6 - adjustable lacing ; 7 - inflatable capstan tubes ; 8 - skin-tight coverall ; 9 - pressure helmet ; 10 - electrically defogging window ; 11 - microphone ; 12 - oxygen inlet ; 13 - life jacket ; 14 - pressure boots ; 15 - rotatable pressure helmet ; 16 - rotating seal ; 17 - parachute harness ; 18 - pressure gloves ; 19 - zip fasteners for dressing.



A - North American/U.S.A.F. X-15 full pressure suit.

B - U.S.A.F. MC4 partial pressure suit.

C - U.S. Navy Goodrich full pressure suit.

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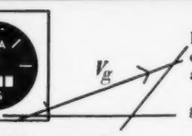

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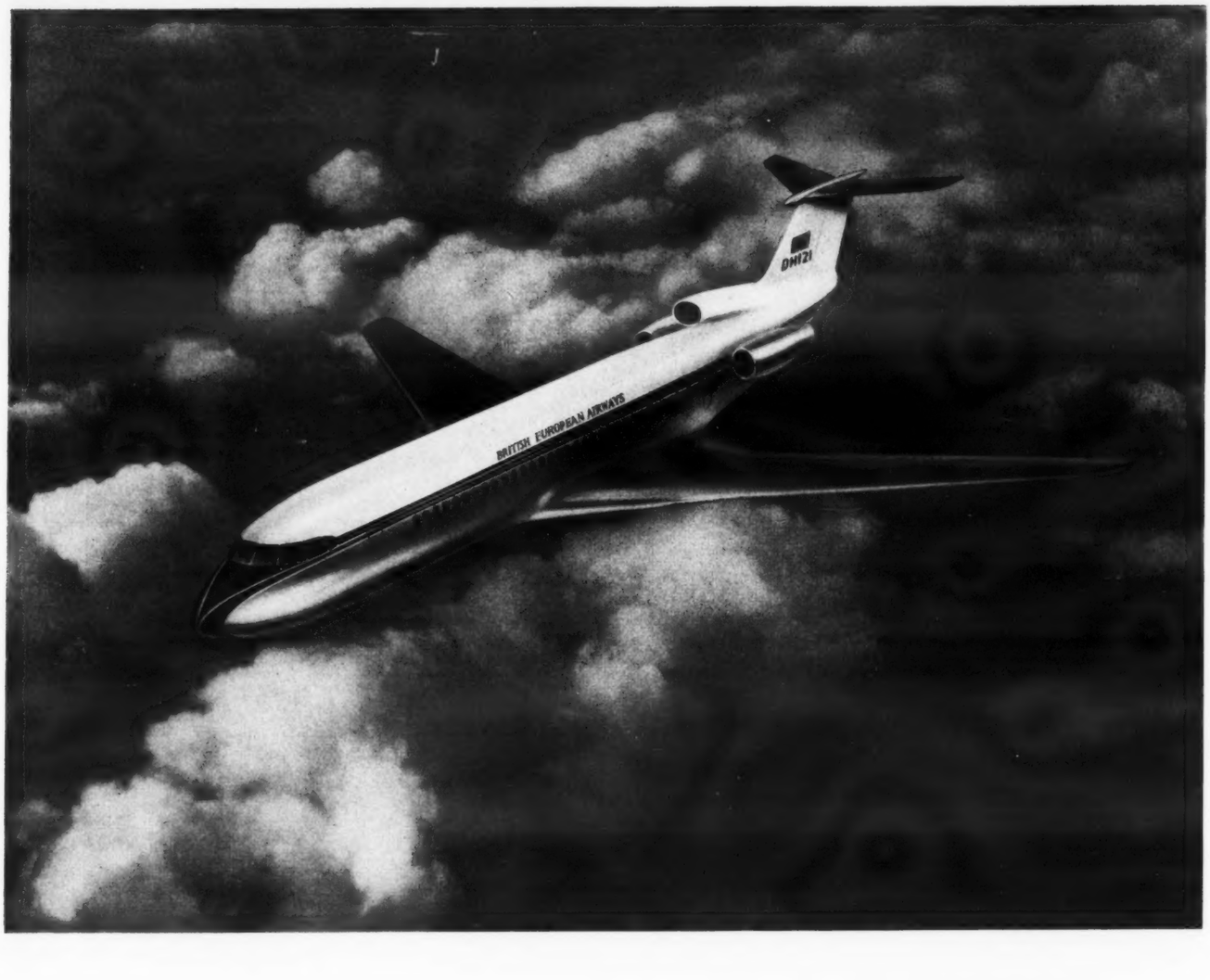

British European Airways, who have ordered a fleet of Comets to introduce jet speed and jet comfort on their airline network from 1960, have now chosen the DH. 121 to follow in 1964. Both types are powered by Rolls-Royce engines.

The DH. 121 will carry 100 passengers on short and medium stages at speeds of more than 600 miles an hour.

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The Pentagon's New Missile and Space Projects

Following the establishment of the Pentagon's *Advanced Research Projects Agency* and the appointment of Roy W. Johnson as Director, Defense Secretary Neil McElroy has outlined the future activities of the new organization. At a four-hour briefing, Pentagon officials revealed to the press a fantastic family of weapons and space vehicle projects:

1. Development of a manned space vehicle (such as the North American X-15);

2. Launching of an unmanned multi-stage rocket vehicle capable of reaching the moon and designed to explode on landing;

3. Utilization of the *Thor* or *Atlas* missiles as the carrier vehicle for a small manned space vehicle, which would itself be equipped with jet controls, wings or even parachutes to bring it back to earth;

4. Development of surveillance satellites for all three branches of the Armed Forces (cf. Rockets, Missiles and Space Vehicles, page 243);

5. The development of rocket engines powerful enough to put up space platforms and space ships. In particular the development of a liquid propellant rocket engine capable of delivering 1,000,000 lb. of thrust, and the development of new solid propellant engines to power space vehicles weighing several hundred tons. North American Aviation is reported to have twelve test stands in California's Santa Susana mountains capable of testing liquid propellant motors of this category; at Edwards Air Force Base the U.S.A.F. has a test stand for engines up to 1,500,000 lb. thrust. The U.S.A.F. has reported that the largest solid propellant rocket engine ever built is soon to be test fired by Thiokol Chemical Corporation.

Until Johnson takes over as Director on April 1st, Defense Missile Director William Holaday will continue to administer A.R.P.A. on a caretaker basis. In this capacity Holaday has already approved certain expenditures for the study of new satellite launching sites which will permit greater freedom in the selection of orbits than presently possible at Cape Canaveral. Holaday is expected to approve an " interim " space exploration program in the very near future, and this would involve the selection of certain military missiles, presumably *Thor* and *Jupiter* IRBMs, for limited space work. Meanwhile Dr. James R. Killian, the President's personal scientific advisor, is working out detailed proposals for the creation of a " National Space Authority ", outlining the United States military and civilian objectives in space and recommending governmental action to attain these goals.

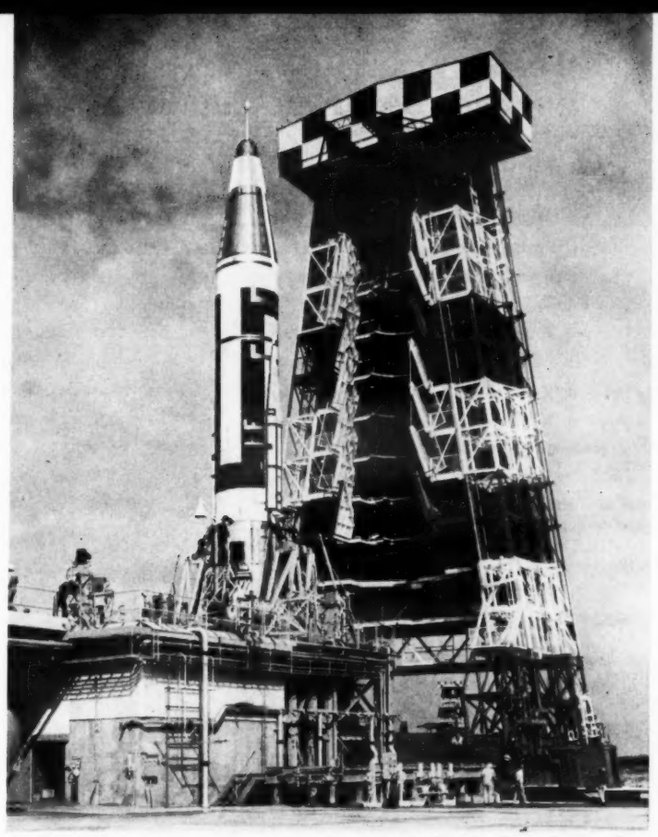
*

In addition to these revolutionary projects the Pentagon has also announced a whole series of new weapons which are either in a stage of advanced development or are already undergoing tests, and which will join the United States armoury in the not too distant future:

1. A top priority project is the U.S.A.F.'s medium-range ballistic missile, with a range of 1,500 miles, which would be launched from a high-altitude carrier aircraft; this weapon will probably be smaller than, for example, the *Thor* or *Jupiter* IRBMs, and is intended as a successor to the North American WS-131B *Hound Dog* air-to-suface weapon now under development. No names of contractors for the new missile have been announced.

2. As a successor to the Douglas MB-1 *Genie* unguided air-to-air missile (with atomic warhead), the U.S.A.F. is proposing an air-to-air guided missile, also with atomic warhead, on the lines of the *Falcon*. It is not yet clear if this is to be a direct development of the Hughes *Falcon*, but development of the new air-to-air weapon, equipped with radar or infra-red homing head, is reported to be in hand.

3. The McDonnell-produced GAM-72 *Green Quail* air-to-ground missile and the Fairchild Engine and Airplane Corp.'s SM-73 *Bull Goose* ground-to-ground weapon which is now being tested, are both " decoy " weapons. Their mission will be deception of the enemy's air defences, particularly radar systems. Neither the GAM-72 *Green Quail*, which will be mounted in long-range bombers, or the ground-launched SM-73 *Bull Goose* will have warheads; both weapons are intended exclusively for



An *Atlas* ICBM on its launching pad at the U.S.A.F. Missile Test Center, Cape Canaveral, Florida.

Strategic Air Command. Sub-contractors for the *Green Quail* program are: Boeing—modifications of the B-52 jet bomber to carry the GAM-72; General Electric—power units, probably J 85 turbojets; American Machine and Foundry Company—auxiliary equipment; Ramo-Wooldridge—electronic equipment. The following sub-contractors have been named for the *Bull Goose*: American Machine and Foundry Company—ground equipment; Ramo-Wooldridge—electronic equipment; Paul Omohundro Co.—airframe elements; power units will probably be supplied by the prime contractor Fairchild (J 83).

4. Temco Aircraft Corp., Dallas, Texas, is developing the *Corvus* air-to-surface missile for the U.S. Navy for employment against surface units or heavily defended land targets. The *Corvus* will be powered by a Reaction Motors Inc. rocket motor, and the guidance system will be supplied by the Texas Instrument Company.

5. In an advanced stage of development the North American WS-131B *Hound Dog* air-to-ground missile is intended for employment in the Boeing B-52 long-range bomber. In essentials this weapon is a glide bomber with atomic warhead, a range of several hundred miles, and is comparable to the British stand-off bomb.

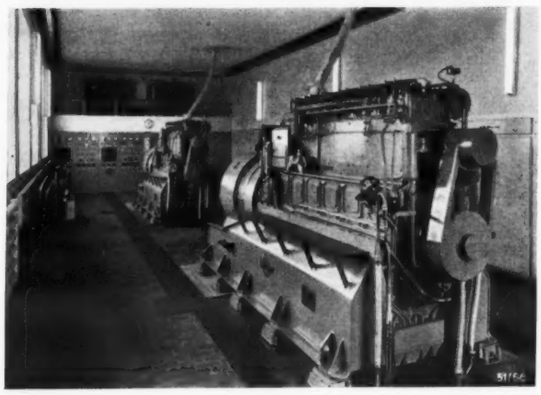
6. The *Sergeant* ballistic missile (Thiokol solid-propellant rocket engine) is scheduled to supersede the *Corporal* short-range missile (Ryan liquid propellant rocket engine) in the 1960s; the *Corporal* is currently deployed by the U.S. Army in both the United States and Europe. Jet Propulsion Laboratory of Pasadena is the prime contractor, and the Sperry Gyroscope Company is responsible for equipment components. *Sergeant* rockets are also being employed as second stages in various satellite vehicles, with *Thor* or *Jupiter* first stages.

7. In the anti-missile program the Radio Corporation of America (prime contractor) has received a large contract for initial work on an early warning radar system capable of acquiring and tracking ballistic missiles at ranges up to 3,000 miles. In addition to a series of upper air surveillance radar equipments the first requirement is for three radar stations, each with two special equipments, for acquiring and tracking missiles. One of these equipments will emit a tight cluster of radar beams for extremely accurate detection of targets; the second will be a tracking radar able to discriminate between missiles, ionized meteorite trails and satellites, and will give more accurate impact prediction data. A radar of the latter type has already been used to track the Soviet satellites. The new radar system will be integrated with the SAGE Computing System and is expected to provide an average warning time of 15 minutes.

Emergency Power Supply for Air Traffic Control

For some years past the firm of Ad. Strüver GmbH, Hamburg, has been devoting a major portion of its production facilities to the manufacture of equipment for airports. In addition to its well-known sound-proofed starter sets, the Power Supply Unit Division is now offering emergency power supply sets for air traffic control installations. The fully automatic sets take over when the local grid supply fails.

The Strüver emergency power supply unit shown here is installed at Hamburg airport and consists of two Deutz six-cylinder diesel motors which drive two 190 kVA 220/380 volt a.c. generators at 600 r.p.m. It also incorporates a switching unit and a synchronizing unit for the parallel operation of both sets. The emergency power supply unit goes into operation immediately, supplying lighting systems, communications equipment and other electrically-operated auxiliary airport equipment with current within seconds. — Strüver also supplies fixed low-power generators for radio beacons, radar equipment and similar equipment.



Emergency power supply unit for air traffic control installations at Hamburg airport.

Swissair President Ernst J. Schmidheiny

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Schmidheiny, who is 55, is Chairman of the Board of Zementfabrik Holderbank Wildegg AG and of the parent company Holderbank Financière Glarus AG, and enjoys close relations with the European cement industry. He has long been interested in aviation—he was an active sports pilot from 1934 to 1939—and has been a member of the Swissair Board since 1947. The new President's financial experience and his close contacts with the major Swiss banks should be of immense value to Swissair in its forthcoming capital transactions—the proposed 50 percent increase in capital.

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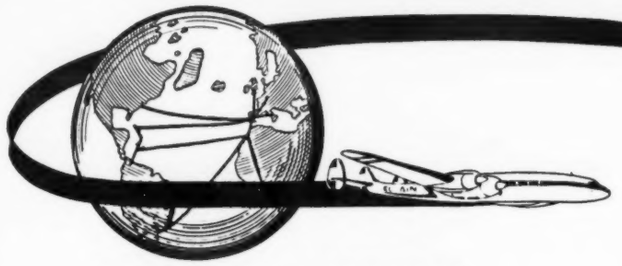

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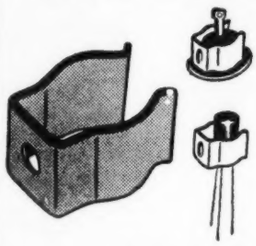

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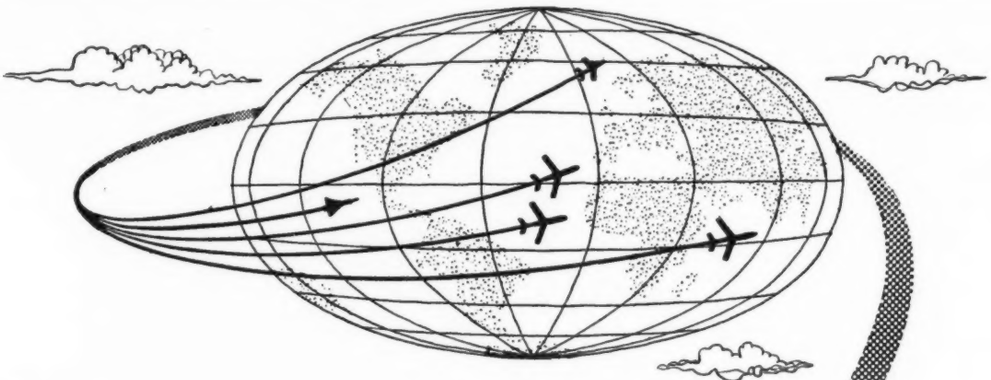

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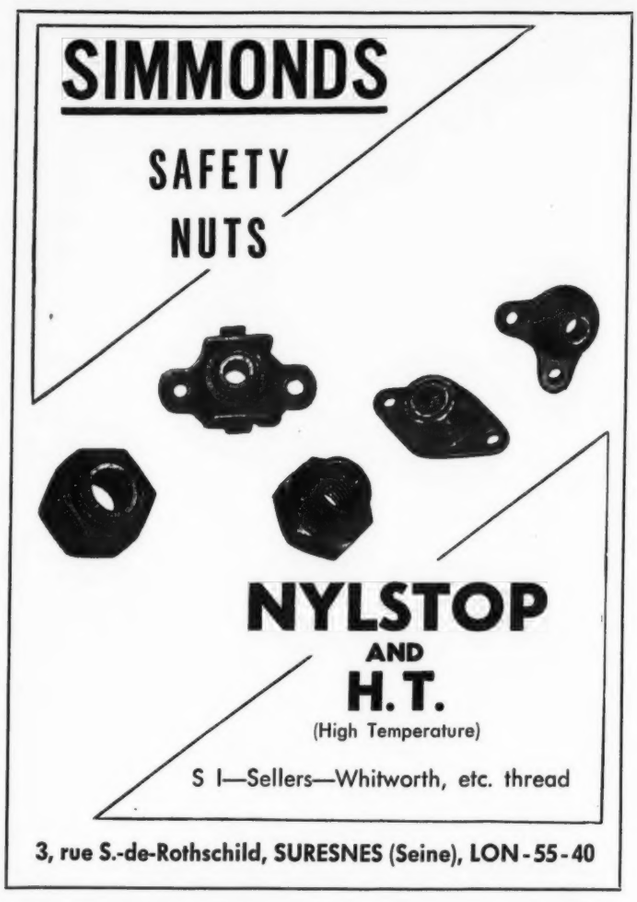

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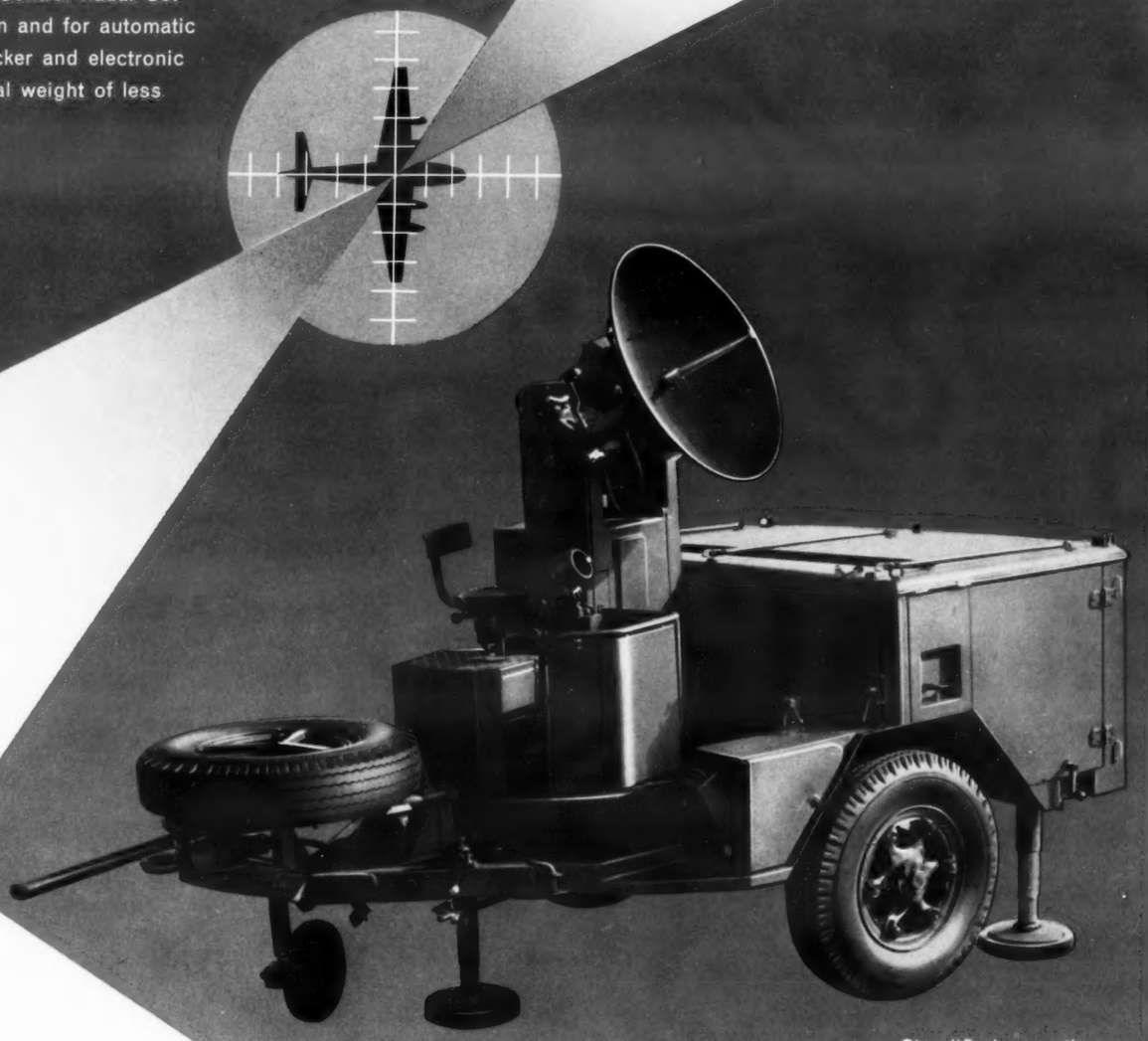

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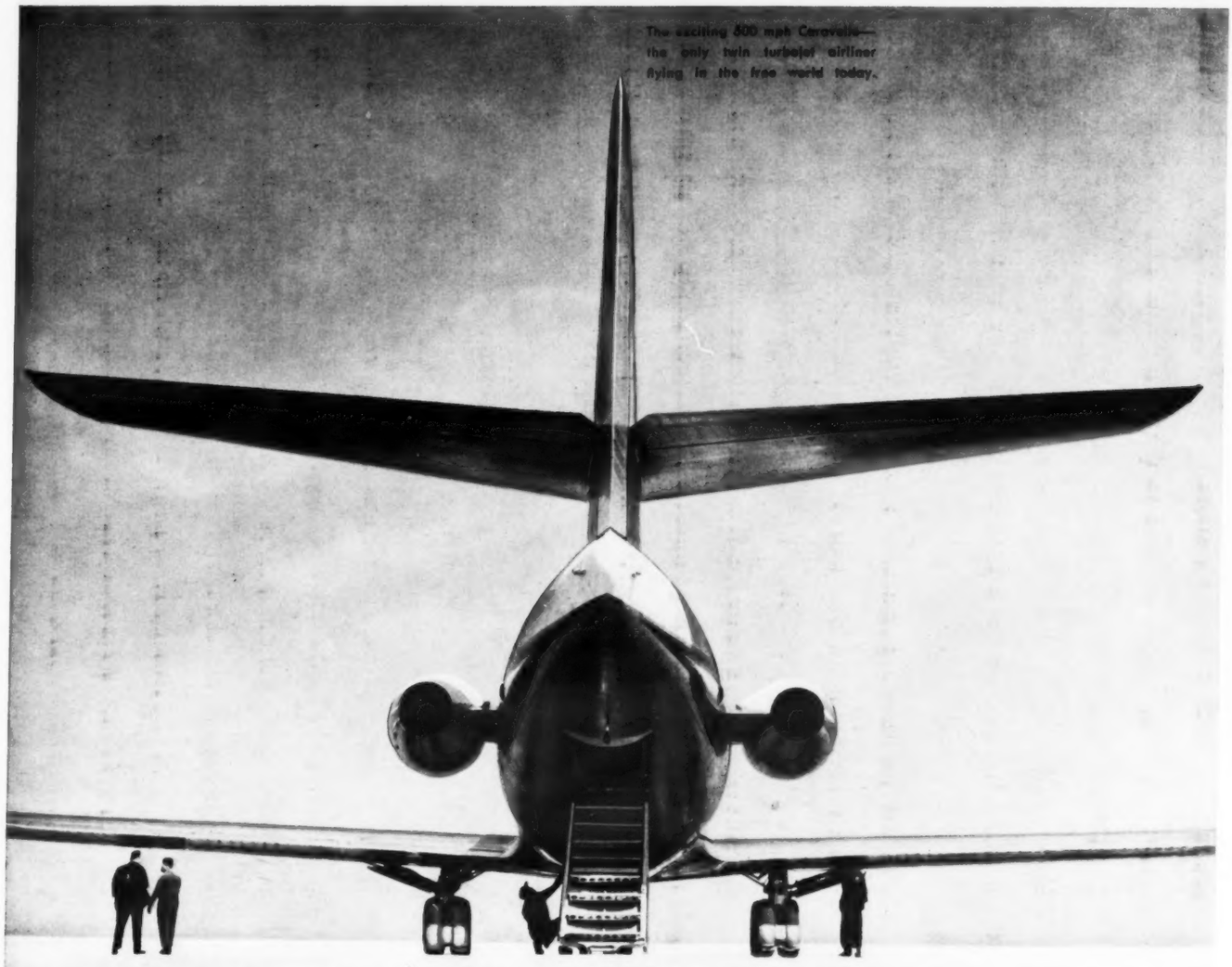

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